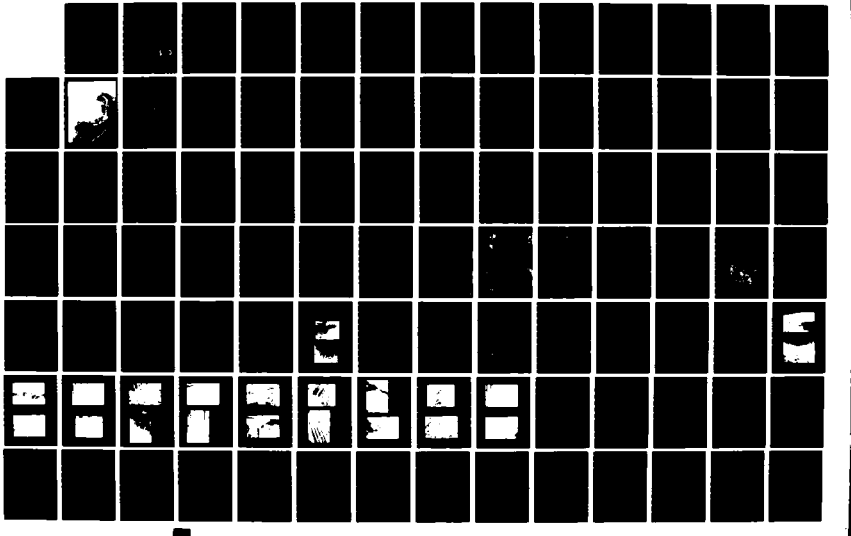
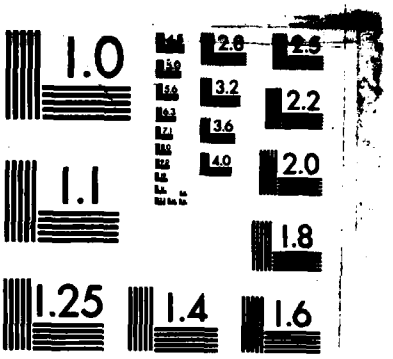
AD-A157 217 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS EAST LONG POND DAM (V.. (U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV APR 80 1/2

UNCLASSIFIED F/G 13/13 NL





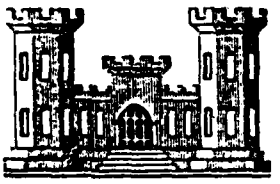
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A157 217

RICHELIEU RIVER BASIN
WOODBURY, VT

EAST LONG POND DAM
VT 00185

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DTIC
ELECTE
JUL 1 7 1985
S D
G

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DTIC FILE COPY

APRIL 1980

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

85 7 01 096

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

REPRODUCED AT GOVERNMENT EXPENSE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: VT 00185	2. GOVT ACCESSION NO.: AD-A157217
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): East Long Pond Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS	5. TYPE OF REPORT & PERIOD COVERED: INSPECTION REPORT
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254	12. REPORT DATE: April 1980 13. NUMBER OF PAGES: 54
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Richelieu River Basin
Woodbury, VT.
Nochols Brook

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a 260 ft. long, 20 ft. high earth embankment with an outlet structure in the center of the dam. THe dam is in fair condition. The visual inspection revealed some minor problems. It is intermediate in size with a high hazard potential. There are various remedial measures and recommendations which the owner must undertake.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

REPRODUCED AT GOVERNMENT EXPENSE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED-E

AUG 26 1980

Honorable Richard A. Snelling
Governor of the State of Vermont
State Capitol
Montpelier, Vermont 05602

Dear Governor Snelling:

Inclosed is a copy of the East Long Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the East Long Pond Dam would likely be exceeded by floods greater than 13 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Our screening criteria specifies that a dam of this class which does not have sufficient spillway capacity to discharge fifty percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The term "unsafe" applied to a dam because of an inadequate spillway does not indicate the same degree of emergency as that term would if applied because of structural deficiency. It does indicate, however, that a severe storm may cause overtopping and possible failure of the dam, with significant damage and potential loss of life downstream.

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy preciptiation, round-the-clock surveillance should be provided.

NEDED-E
Honorable Richard A. Snelling

I have approved the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to the Department of Water Resources, the cooperating agency for the State of Vermont. This report has also been furnished to the owner of the project, Village of Hardwick, Electric Light Department, Hardwick, Vermont 05843.

Copies of this report will be made available to the public, upon request to this office, under the Freedom of Information Act, thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Water Resources for the cooperation extended in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Accession For
NTIS GRA&I
DTIC TAB
Unannounced
Justification
By
Distribution
Availability
Dist
A/23

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification Number:	00185
Name of Dam:	East Long Pond Dam
Town:	Woodbury
County and State:	Washington, Vermont
Stream:	Nichols Brook
Date of Inspection:	October 25, 1979

East Long Pond Dam is a 260-foot-long, 20-foot-high earth embankment with an outlet structure in the center of the dam. It was reconstructed in 1930 to provide water supply for the generation of hydroelectric power at Mackville Dam, 2½ miles downstream. Water from East Long Pond currently augments flows at Pottersville Dam on the Lamoille River. The appurtenant works consist of a 12-foot auxiliary spillway in the center of the dam; a 100-foot wide emergency spillway in the right abutment; and a gated 36-inch diameter conduit. The engineering information available on the structure consisted of past inspection reports by two bureaus of the State of Vermont and a 1930 report of construction activities.

The visual inspection of East Long Pond Dam revealed some minor problems. The general condition of the dam is considered fair. The inspection revealed trees growing on the crest and slopes, deterioration of concrete on the auxiliary spillway, a large amount of driftwood accumulated at the dam, and a gate operating mechanism in poor repair.

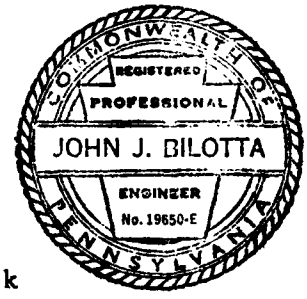
Based on the dam's Intermediate size and High hazard classification in accordance with the Corps' guidelines, the test flood is the full PMF. The test flood for a drainage area of 4.6 square miles is approximately 8100 cfs. With the water level at the top of the dam, the spillways will discharge 745 cfs (13% of the routed test flood outflow). Storage provided by the pond (1040 acre-feet) will attenuate the test flood to a projected outflow of 5650 cfs which will overtop the dam by 3.3 feet.

It is recommended that the owner engage a qualified registered engineer to design repairs to the downstream face of the auxiliary spillway and training walls, investigate a discrepancy between the as-built drawings and the field conditions, eliminate problems caused by floating debris, remove vegetation from the crest, investigate alternatives to the gate operating mechanism, and perform a detailed hydrologic and hydraulic investigations to determine the need and means of increasing the discharge capacity of the project. The owner should initiate an active maintenance program and develop formal surveillance and downstream flood warning plans, including round-the-clock monitoring during heavy precipitation.

The recommendations and remedial measures are described in Section 7 and should be addressed within one year after receipt of this Phase I Inspection Report by the owner.

Very truly yours,

DuBois & King, Inc.



John J. Bilotta, P.E.
Project Manager

JJB/dbk

This Phase I Inspection Report on East Long Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

RICHARD DIBUONO, MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRIAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

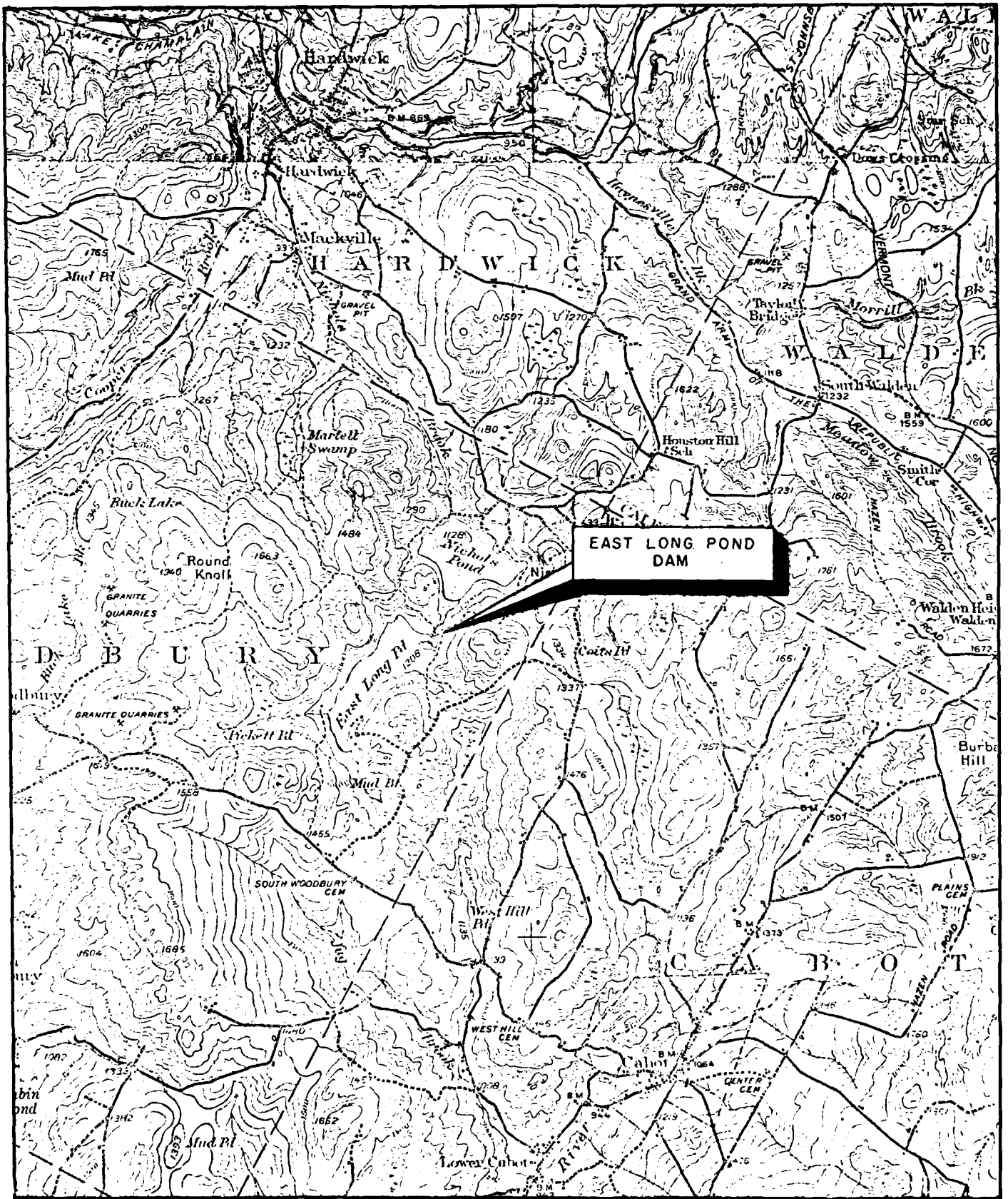
Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably-possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that

a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

OVERVIEW PHOTOGRAPH - EAST LONG POND DAM



DuBois & King inc.
engineering and environmental services
RANDOLPH, VERMONT CONCORD, NEW HAMPSHIRE

NATIONAL DAM INSPECTION PROGRAM

EAST LONG POND DAM

LOCATION MAP

USGS QUAD. - PLAINFIELD, VERMONT

DRAWN BY	DATE
JAS	12/79
CHECKED BY	PROJ NO
RMC	91110
PROJ ENG	DRAW NO

SCALE: 1:62500

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
EAST LONG POND DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. DuBois & King, Inc., has been retained by the New England Division to inspect and report on selected dams in the State of Vermont. Authorization and notice to proceed were issued to DuBois & King, Inc., under a letter of October 19, 1979, from William E. Hodgson, Jr., Colonel, Corps on Engineers. Contract No. DACW33-80-C-0003 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to quickly initiate effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. East Long Pond Dam is located on Nichols Brook in the Town of Woodbury, Vermont, approximately three and one-half miles upstream from its confluence with Cooper Brook. Nichols Brook joins Cooper Brook about one and one-half miles above its mouth; consequently, East Long Pond Dam is located about five miles upstream from the Lamoille River. The dam is shown on the 15-minute USGS quadrangle for Plainfield, Vermont, with coordinates approximately 72° 20.9' west longitude, 44° 26.9' north latitude, Caledonia County, Vermont. The location of East Long Pond Dam is shown on the Location Map immediately preceding this page. The site of the dam is relatively inaccessible, requiring travel by either 4-wheel drive vehicles or hiking.

b. Description of Dam and Appurtenances. East Long Pond Dam is an earth embankment with a masonry and concrete outlet structure approximately in the center of the dam. The embankment has a top width of 10 feet, side slopes of 2:1 and it is 260 feet long. Its structural height is 20 feet. The outlet structure reportedly has two gates 2.5 feet by 6 feet that control flow into a 36-inch diameter culvert. There is a 12-feet-wide overflow section which serves as an auxiliary spillway at elevation 1208.8 NGVD. The emergency spillway is located in the right abutment and it has an 18-inch wide concrete sill, 100 feet long at elevation 1208 NGVD.

c. Size Classification. East Long Pond Dam is 20 feet high and has a storage volume of 3620 acre-feet of water. In accordance with §2.1.1 of the Recommended Guidelines for Safety Inspection of Dams, the dam is Intermediate in size based upon its storage capacity which is greater than 1,000 acre-feet but less than 50,000 acre-feet.

d. Hazard Classification. The dam has a hazard classification of High based upon its potential for damage. Approximately 3 miles downstream lies Mackville Dam. The flood wave generated by a breach of East Long Pond Dam would be approximately 11 feet high when it reached the Mackville Dam Pond. It is considered that the flood wave generated by a breach of East Long Pond Dam would cause subsequent overtopping of Mackville Dam. Appreciable damage could occur at that site to five dwellings with flood levels up to 5 feet above the first floor. In addition, another residential area one-half mile further downstream than Mackville has about 10 more residences that would be subject to the resultant flooding. It is possible that more than a few lives may be lost if East Long Pond dam is breached.

e. Ownership. This dam is owned by the Village of Hardwick Electric Light Department. The dam was formerly owned by Green Mountain Power Corporation.

f. Operator. The dam is operated and maintained by the Village of Hardwick, Vermont 05843. Mr. William Fee, Village Manager, is in charge of all Village equipment. His telephone number is 802/472-5201.

g. Purpose. The original purpose of the dam was to provide water supply to operate Mackville Dam for power generation. The power generating facilities of Mackville Dam have been eliminated; however, the outflow from East Long Pond Dam is used to augment the flows for another dam on the Lamoille River at Pottersville, which generates power for the Village of Hardwick Electric Light Department.

h. Design and Construction History. The dam was reconstructed at its present location in 1930. Part of the outlet structure from an earlier dam was incorporated into the reconstruction. All other structural elements including the embankment and emergency spillway sill were constructed in 1930. The reconstruction was designed by Trojan Engineering Company of New York City in 1929. Registered Engineer H. K. Barrows certified the as-built plans in 1930 for the Public Service Commission.

i. Normal Operating Procedure. East Long Pond Dam is maintained for flow augmentation for a power dam on the Lamoille River. The gates are reportedly opened in mid-summer and the pond level is maintained at approximately one foot below spillway level (1208 NGVD). The gates are then closed in the spring to raise the pool level and normal flows exit via the emergency spillway.

1.3 Pertinent Data

a. Drainage Area. The drainage basin of Nichols Pond Dam includes an area of 3.5 square miles. The land is mostly forested and the terrain is extremely steep and mountainous. The basin is sparsely populated and there are very few houses and no paved roads.

The maximum reservoir area of 187 acres represents approximately 6% of the total drainage area. The predominant soils in the watershed are Glover-Calais and Calais-Buckland.

b. Discharge at the Dam Site.

(1) Outlet Works. A conduit is located in the outlet control structure. Reportedly, there are two 2.5-feet by 6-feet flood gates on the upstream side. There is only a 36-inch diameter pipe which exits the downstream face.

In order to open the gates the operator must walk across the emergency spillway, and then stand in the center of the auxiliary spillway, and then assemble the gate operating mechanism. For this reason and because of the inaccessibility of the site, it was considered that the gates would not function during high water.

The maximum capacity of the conduit is considered to be approximately 150 cfs based upon inlet control with a water surface at top of dam (el. 1210 NGVD).

(2) Maximum Known Flood. There were no records available nor were there any witnesses of any past flooding at the site.

(3) Spillway Capacity at Top of Dam. The emergency spillway is a natural saddle area in the right abutment. There is a 100-foot-wide concrete sill which is partially buried. Presently a length of 70 feet of the sill is exposed. An estimate of 80 feet of available weir length was used in the calculations to approximate the effects of the buried sill. The auxiliary spillway is a 12-foot wide by 1.6-feet high rectangular opening in the outlet structure.

When the water is at the top of dam, elevation 1210.0, the emergency spillway will discharge 700 cfs and the auxiliary spillway will discharge 45 cfs for a total capacity of 745 cfs. This total project discharge (745 cfs) with a water level at the crest of the dam is equivalent to 13% of the routed test flood outflow.

(4) Spillway Capacity at Test Flood Elevation. The full PMF test flood inflow for the 3.5 square mile drainage area is 8100 cfs. Storage of 1,040 acre-feet will attenuate the peak ouflow to 5,650 cfs at elevation 1213.3 this represents an overtopping of the dam by 3.3 feet. The spillways will contribute 3,370 cfs (60%) of the routed test flood outflow,(5,650 cfs).

(5) Total Project Discharge. The total project discharge at the top of dam is 745 cfs at elevation 1210.0. During the test flood, when the inflow is 8,100 cfs, the total project will discharge 5,650 cfs at elevation 1213.3.

c. Elevation (NGVD)

(1)	Streambed at toe of dam	1190.0
(2)	Bottom of cutoff (assumed)	1188.0
(3)	Maximum tailwater	N/A
(4)	Recreation pool	1208.0
(5)	Full flood control pool	N/A
(6)	Emergency Spillway crest (ungated)	1208.0
(7)	Auxiliary Spillway crest (ungated)	1208.8
(8)	Design surcharge (Original Design)	Not known
(9)	Top of dam	1210.0
(10)	Test flood surcharge	1213.3

d. Reservoir (Length in feet)

(1)	Normal pool el. 1208.0	6000
(2)	Flood control pool	N/A
(3)	Spillway crest pool el. 1208.0	6000
(4)	Top of dam el. 1210.0	6,100
(5)	Test flood pool el. 1213.3	6,500

e. Storage (acre-feet)

(1)	Normal pool	3250
(2)	Flood control pool	N/A
(3)	Spillway crest pool	3250
(4)	Top of dam	3620
(5)	Test flood pool	4260

f. Reservoir Surface (acres)

(1)	Normal pool	181
(2)	Flood control pool	N/A
(3)	Spillway crest	181
(4)	Test flood pool	202
(5)	Top of dam	187

g. Dam

(1)	Type	Earth embankment
(2)	Length	260 feet
(3)	Height	20 feet
(4)	Top Width	10 feet
(5)	Side Slopes	2:1 Upstream/Downstream
(6)	Zoning	Rock fill at toe
(7)	Impervious Core	Clay core
(8)	Cutoff	2 feet by 5 feet
(9)	Grout Curtain	None

h. Diversion and Regulating Tunnel

Not applicable.

i. Spillway		Emergency	Auxiliary
(1)	Type	Saddle	Notch
(2)	Length of Weir	100 feet (per plans) 70 feet (exposed)	12 feet
(3)	Crest elevation (no flash boards)	1208.0	1208.8
(4)	Gates	None	None
(5)	Upstream Channel	Approach channel to emergency spillway is shallow and clogged with debris. There is no approach channel for the auxiliary spillway.	
(6)	Downstream Channel	Downstream channel of emergency spillway is natural channel with rubble invert. Downstream channel of auxiliary spillway is a narrow channel with a few overhanging trees on its banks. Channel bottom consists of boulders and rock outcrops.	

j. Regulating Outlets

(1)	Invert (NGVD)	1191.4
(2)	Size	36-inch diameter
(3)	Description	Concrete pipe
(4)	Control	Hand operated gates 2-(2.5 ft x 6 ft) gates connected to 36-inch diameter conduit

SECTION 2
ENGINEERING DATA

2.1 Design

Information on the design of East Long Pond Dam is not available. The Vermont Public Service Board has microfilmed files of Vermont Public Service Commission, a predecessor of the present agency. Among those files is an application for reconstruction of East Long Pond Dam with a one-page specification.

2.2 Construction Data

The microfilmed files mentioned above also yielded a construction progress report to the Public Service Commission by H. K. Barrows, a consulting engineer. This report describes the structure, recommends changes to the original design, and contains a marked copy of one construction drawing with as-built notes.

2.3 Operation

No operating manual was available for East Long Pond Dam. Operating personnel reported that the facilities were operated annually to effect flow augmentation for hydro-power. There is no known schedule for monitoring the structure. There are records of past inspections performed by the Vermont Department of Water Resources and the Public Service Commission.

2.4 Evaluation

a. Availability. A minimum amount of design information is available. It was not considered to be sufficiently detailed to determine the stability of the structural components. There was no information available on the hydrologic design. The Vermont Department of Water Resources has a file on past inspection reports.

b. Adequacy. The available data was not sufficiently detailed to allow for a definitive review. The design print was barely legible, and the one-page specification was vague. Consequently, more emphasis was placed upon the findings of the visual inspection, records of past performance, and sound hydrologic and structural engineering judgment.

c. Validity. Some of the design aspects did not totally agree with the findings of the visual inspection. For example, the design data shows the breadth of the crest to be 5 feet, whereas it was measured to be 10 feet in the field.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General

The field inspection of East Long Pond Dam was performed on October 26, 1979. The weather was cloudy and cold with temperatures near 32°F. The inspection team included personnel from DuBois & King, Inc.; Geotechnical Engineers Inc.; and Knight Consulting Engineers, Inc. accompanied by a representative of the Village of Hardwick. A copy of the inspection checklist as completed during the field inspection is included as Appendix A. At the time of the inspection the water was 3.75 feet below the crest of the dam (elevation 1206.25 NGVD). Operating personnel explained that this was not the general case since the reservoir would generally be kept full to the crest of the emergency spillway, elevation 1208. It was explained that vandals regularly opened the gates, therefore the gate operating mechanism had been disassembled. The operating wheel was chained to a tree, and the worm gear was kept at the Village garage approximately 3½ miles downstream.

b. Dam

The dam is an earth embankment (Photo 1), which reportedly has a clay core. It is constructed 2.0 to 2.5 feet higher than the emergency spillway crest.

The upstream slope is covered partially by riprap consisting of boulders. However, several areas show missing riprap (Photo 3) and some areas show some erosion. Erosion has occurred against the spillway walls (Photo 3). The upper part of the upstream slope, the crest, and the downstream slope are overgrown with trees and bushes (Photo 4).

The downstream slope is strewn with boulders (Photo 5), and its surface is irregular. Voids were observed under and between boulders. No evidences of seepage were observed on the slope, at the toe, or immediately downstream of the dam. A modificaton to the original design indicates that the dam crest was to be set at 4 feet above the emergency spillway level. The inspection found that the majority of the crest was 2 to 2.5 feet higher than the crest of the emergency spillway.

c. Appurtenant Structures

The auxiliary spillway is a concrete structure. In the upstream walls and floor, there is some spalling and minor cracking of the concrete (Photos 11 and 15). A small piece of unreinforced concrete cap has broken off at the right side of the riser (Photo 12), without affecting the operation or safety of the spillway. Generally the concrete is in good condition. The downstream face of the spillway structure (Photo 6) had a cyclopean concrete at mid-height which appears moist and has developed severe spalling and erosion.

There is an area of seepage at the base of the right downstream wall of the spillway discharge channel (see close-up in Photo 7). Both training walls are dry stone masonry and rest directly over bedrock (Photos 8 and 9). Both walls are composed of irregularly shaped stones with dimensions ranging from 3 inches to 2 feet on a side. The voids between the stones vary from direct contact to several inches but most stones could not be moved by hand. Stones in the channel at the base of each wall may be an indication that stones have fallen from the top of the walls.

The outlet gate mechanism (Photo 11) has been disassembled. The operator has removed a wheel and chained it to a tree to prevent trespassers from operating the gate. Operation of the gate would require crossing both spillways, thus in case of flood, it is reasonable to assume that the gate would not be operated. Although the timber rising stems (which operate in unison) are in apparently good condition, the roller guide has broken away and has been replaced by a galvanized channel (Photos 11 and 12). It was reported that this adaptation does not allow the gate mechanism to operate as freely as it did previously. The metal plates, upon which the rollers formerly travelled, have come loose and bind against the galvanized channel (Photo 14). The makeshift timber trashrack upstream of the control gates appears to be adequate to provide protection but some elements are missing (Photo 13).

The emergency spillway is a wide (about 100 feet) channel, constructed at the right abutment, with a concrete weir (Photo 17), which is partially buried by soil and debris. The left bank of the channel is protected with riprap against the dam. The right bank of the channel is formed by the natural ground of the right abutment (Photo 2). About 50 feet to 100 feet downstream of the weir there was rust-colored water moving slowly along the channel (Photo 18), which may indicate seepage passing under the weir. Seepage was also observed emerging from the left bank of the channel.

d. Reservoir Area

The reservoir edge in the vicinity of the dam shows no indication of instability. However there are many dead trees and other debris that have accumulated adjacent to the dam. There appear to be several accumulations of fallen trees around the edge of the reservoir. It is considered likely that during a period of high or unusual runoff, these may float to the dam, clog the spillways, impinge upon trees at the crest of the structure, and jeopardize the safety of the dam.

e. Downstream Channel

The downstream channel for the auxiliary spillway is apparently the natural streambed (Photos 10 and 16). The downstream channel of the emergency spillway was described in Section 3.1.c and joins the natural streambed a few hundred feet downstream of the dam. Farther downstream, the channel crosses the remains of a breached granite block and earth fill dam (Photos 19 and 20).

3.2 Evaluation

On the basis of the visual inspection, the dam is judged to be in fair condition. Factors that can endanger the future safety of the dam are the following:

a. Trees growing on the dam can lead to seeps due to rotting of roots or to damage to the dam if the trees would be overturned during high wind.

b. Present concrete deterioration and minor seepage on the downstream face of the auxiliary spillway and the right training wall present no immediate danger to the safety of the dam; however, increased deterioration and seepage could cause problems in the future.

c. Floating debris at the edges of the reservoir could become a serious problem if not removed and destroyed. During a period of high or unusual runoff, they may clog the spillway or catch on trees on the crest and downstream if the structure is overtopped.

d. The gate operating mechanism is in danger of failing. a failure would require extraordinary means to empty the pond for repairs or maintenance.

SECTION 4

OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. Operational Procedure consists primarily of opening the gates in the summer time in order to augment flows to the power dam downstream on the Lamoille River. In order to operate the sluice gates, the operator must stand on the crest of the spillway and assemble the mechanism which raise and lowers the timbers attached to the gates. Part of the gears are kept at the Village maintenance shed approximately 3½ miles downstream. There is no written procedure for lowering the pool level or opening the gates in preparation of a possible flood event. A 1949 inspection report by an engineer for the Public Service Commission warned that both East Long Pond and Nichols Pond should not be kept full during flood season (which was not defined). There is neither any indication that the policy was adopted nor any written operational guidelines for establishing the level of the two ponds.

b. Warning System. There is no system to warn of an impending flood, of possible overtopping or of other problems with the dam.

4.2 Maintenance Procedures

a. General. There is no set program for maintaining the dam. Maintenance is performed on an as needed basis. The only operating facilities on the dam are the two sluice gates. At the time of the inspection, the timber stems for both gates were in good condition but the metal parts require attention. The gates are operated twice a year; opened in mid-summer and closed in spring.

4.3 Evaluation

The fallen trees surrounding the reservoir represent a potential problem. If not removed they may endanger the dam during a flood situation. Many fallen trees and large branches are floating near the shoreline. The debris may be the result of either logging operations or trees fallen by high winds, or both. The largest accumulations of branches and other floatable debris is adjacent to the dam indicating that the prevailing winds may tend to push debris toward the dam. During an event of heavy precipitation, when rains may be accompanied by high winds, more of the floating debris may be driven toward the dam. This may increase the possibility of clogging the spillway with debris or the possibility of debris snagging on other obstructions (such as trees on the dam crest) which could increase the height of possible ove topping during a catastrophic storm event. No written procedure for maintaining the reservoir area was uncovered.

Current procedures are considered to be inadequate to insure that all problems encountered can be remedied within a reasonable period of time. The owner should establish written procedures for operating and maintaining the structure.

SECTION 5
EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

East Long Pond Dam has two fixed crest weirs and one 36-inch diameter pipe which is controlled by two 30-inch by 72-inch gates. The emergency spillway is set at elevation 1208 msl. It is controlled by a concrete sill the bottom of which is buried at least two feet below original grade. The sill is 100 feet in length but only 70 feet were visible at the time of the inspection. Consequently a weir length of 80 feet was selected for computational purposes. It was reported that the lake is usually kept at this level and water is allowed to trickle this sill.

The 12-foot wide weir over the control structure was originally designed to be at the same elevation as the emergency spillway. Post construction changes have raised the crest to 9-inches above the emergency spillway. Consequently, this crest was considered to be an auxiliary spillway.

With the reservoir level at the top of the dam, the auxiliary spillway would convey 45 cfs and the emergency spillway would convey 700 cfs. Thus the project would discharge 745 cfs at the top of the dam (elevation 1210).

The pond outlet is controlled by two gates with wooden stems which rise vertically in the center of the spillway in the upstream face. No rating or other anlysis was performed for the outlet. The location of the gate operating mechanism in the center of the spillway would obviously prevent gate operation during periods of high water.

The watershed of East Long Pond is relatively steep mountainous terrain covered for the most part with trees and forest. The lake area at full pool of 188 acres represents 9 percent of the total watershed.

5.2 Design

No data on the hydrologic design of East Long Pond Dam was located.

5.3 Experience Data

There are no recorded experiences of overtopping or any visual accounts of such. However, a 1974 inspection report by an engineer for the Vermont Department of Water Resources indicates that severe erosion occurred downstream of the emergency spillway crest during a period of excessive runoff in June 1973. No estimate was made of either high water marks, size of flow or discharge. As a corrective measure the area downstream of the emergency spillway sill was backfilled with rocks and stones obtained at or near the site.

5.4 Test Flood Analysis

The storage capacity of this dam (3620 acre-feet) puts it in the Intermediate class. The hazard classification is High since failure of East Long Pond is likely to endanger the lives of more than a few people at Mackville (3 miles downstream) and in the outskirts of Hardwick Village (3½ to 4 miles downstream). The PMF curve envelope for Mountainous areas was used and a discharge per square mile (2350) was then multiplied by the actual drainage area to obtain the PMF inflow of 8100 cfs. The test flood was then routed through the reservoir assuming the water surface to be initially at the crest of the emergency spillway (elevation 1208.0 NGVD). Calculations indicate that the dam would be overtopped by 3.3 feet (el 1213.3 NGVD). The resulting storage (1040 acre-feet) would attenuate the inflow to 5650 cfs outflow. The routed test flood outflow (5650 cfs) represents a 30% reduction of the test flood inflow. The spillways will pass 745 cfs at the top of the dam; this represents 13% of the routed test flood outflow.

5.5 Dam Failure Analysis

Using the Corp's April 1978 "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs," a dam failure analysis was performed for East Long Pond. Prior to failure, the water level was assumed to be at the crest of the dam (1210.0 NGVD) and the breach height (upstream toe to water surface) would be 20 feet. A rock knoll located on the downstream right embankment, would prevent total failure of the structure. Because of this, a breach width of 70 feet (27% of dam width) was used to compute breach outflow instead of 104 feet (40% of dam embankment) as suggested by the rule of thumb method. Using the Saint-Venant equation, a breach outflow of 10,500 cfs was computed.

The breach would produce a 6.5-foot flood wave and the resultant stage of Nichols Brook would be 8.5 feet above streambed at the initial impact area. Located approximately 3 miles downstream is Mackville Dam. By the time the flood wave reached Mackville Dam, it would be 8.0 feet high and would result in a stage of 11.6 feet. The flood wave would cause subsequant overtopping of Mackville Dam. Appreciable damage could occur at Mackville to five dwellings with flood levels up to 5 feet above the first floor. In addition, another residential area one-half mile further downstream than Mackville Dam has about 10 more residences that would be subject to the resultant flooding. It is likely that more than a few lives may be lost if East Long Pond is breached and therefore the dam is classified as High Hazard.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual inspection did not disclose any indications of structural instability.

6.2 Design and Construction Data

The design and construction data available is very limited. The recommendation by H.K. Barrows to construct the crest 4.0 feet above the crest of the emergency spillway was not done.

6.3 Post Construction Changes

In accordance with the available records, post-construction changes include the raising of the auxilliary spillway crest by nine inches. Repairs have been made to the concrete structure of this spillway. There was no indication of the date of the post-construction changes.

6.4 Seismic Stability

The dam is located in Seismic Zone 2 and in accordance with the Phase I inspection guidelines does not warrant seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Assessment

a. Condition

On the basis of the visual inspection, the dam is judged to be in fair condition. Its future stability can be affected by the trees growing on the dam, by deterioration of the downstream face of the auxiliary spillway, obstruction of the spillways with debris and inadequate spillway capacity.

b. Adequacy of Information

The design and construction information available was very limited; thus the assessment of the condition of the dam is based on the visual inspection. The information on the design provided no substantial base for analysis.

c. Urgency

The recommendations presented in Section 7.2 and 7.3 should be carried out within one year of receipt of this report by the owner, with the exceptions noted in Section 7.2 below.

7.2 Recommendations

The following investigations and needed corrections should be performed under the direction of a registered engineer qualified in the design and construction of dams:

a. Design and construct repairs to the downstream face of the auxiliary spillway and the training walls.

b. Determine the original construction configurations and rectify the ambiguity between the 4.0 feet recommendation of H.K. Barrows and the 2.0 to 2.5 feet presently available between the emergency spillway crest and top of dam. An even settlement of 1.5 to 2.0 feet would not seem reasonable.

c. Design and construct an appurtenance to lessen the likelihood of obstructing the spillways with floating debris.

d. Remove trees and stumps from the crest and slopes of the dam.

e. Design and construct an alternative device to operate the gates without having to stand on the spillways.

f. Perform a detailed hydrologic-hydraulic investigation to determine the need and means of increasing the discharge of the project.

7.3 Remedial Measures

a. Operation and Maintenance Procedures

1. Remove trees and bushes growing on the crest and slopes of the dam.

2. Repair broken gate operating mechanism for the gate operating mechanism; either store at the site or provide protection for parts of operating mechanism; and replace broken concrete.

3. Repair all cracked and spalled concrete.

4. Replace missing riprap and repair eroded areas on upstream slope of dam.

5. Develop formal surveillance and downstream flood warning plans, including round-the-clock monitoring during heavy precipitation.

6. Establish a program of annual technical inspections by a qualified registered engineer which should include monitoring of seepage areas downstream of the auxiliary spillway.

7.4 Alternatives

There are no practical alternatives consistent with the present use of the dam.

APPENDIX A

VISUAL CHECKLIST WITH COMMENTS

INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT East Long Pond

DATE 10-26-79

TIME 11:00-1:30

Weather Cloudy

W.S. ELEV. _____ U.S. ___ DN.S.

PARTY:

1. J. Bilotta D&K
2. S. Knight KCG
3. G. Castro GEI
4. J. Spaulding D&K
5. E. Gilcris Village of Hardwick
6. _____
7. _____
8. _____
9. _____
10. _____

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Foundations	G. Castro	
2. Structural	S. Knight	
3. Hydrologic, Electrical & Mechanical	J. Bilotta	
4.		
5.		
6.		
7.		
8.		
9.		
10.		

INSPECTION CHECK LIST

PROJECT East Long Pond

DATE 10-26-79

PROJECT FEATURE

NAME J. Bilotta

DISCIPLINE

NAME S. Knight

NAME G. Castro

AREA EVALUATED	CONDITIONS
DAM ENBANKMENT	
Crest Elevation	1210.0
Current Pool Elevation	3'-9" below crest 1206.25
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed.
Pavement Condition	N/A
Movement or Settlement of Crest	None observed.
Lateral Movement	Too irregular to judge.
Vertical Alignment	Too irregular to judge.
Horizontal Alignment	Too irregular to judge.
Condition at Abutment and at Conrete Structures	Erosion of upstream face near concrete.
Indications of Movement of Structural Items on Slopes	N/A
Trespassing on Slopes	Not observable.
Vegitation on Slopes	Trees and bushes on downstream slope, tree stumps.
Sloughing or Erosion of Slopes on Abutments	Minor erosion of upstream slope
Rock Slope Protection - Riprap Failures	Extensive displacement of Riprap on upstream stlope - across without Riprap.
Unusual Movement or Cracking at or near Toes	None observed.
Embankment or Downstream Seepage	Some seepage along base of right spillway training wall. NOTE: Some minor cavities were noted along downstream slope of right abutment.
Piping or Boils	None observed or known.
Foundation Drainage Features	None observed or known.
Toe Drains	None observed or known.
Instrumentation System	None observed or known.

INSPECTION CHECK LIST

PROJECT East Long Pond

DATE 10-26-79

PROJECT FEATURE

NAME J. Bilotta

DISCIPLINE

NAME S. Knight

NAME G. Castro

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	None observed.
Bottom Conditions	None observed.
Rock Slides or Falls	None observed.
Log Boom	
Debris	
Conditon of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	No stop logs - makeshift trashrock in operable condition 6x6 timber risers in good condition.

INSPECTION CHECK LIST

PROJECT East Long Pond

DATE 10-26-79

PROJECT FEATURE _____

NAME J. Bilotta

DISCIPLINE _____

NAME S. Knight

NAME G. Castro

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	No control tower.
a. Concrete and Structural	
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	None.
Float Wells	None.
Crane Hoist	None.
Elevator	None.
Hydraulic System	None.
Service Gates	Not operatable - parts have to be brought in from outside; wheel stored by attached to tree. Operator has to cross two spillways to assemble and operate gate by hand only.
Emergency Gates -	None.
Lightning Protection System	None.
Emergency Power System	None.
Wiring and Lighting System in Gate Chamber	None.

INSPECTION CHECK LIST

PROJECT East Long Pond

DATE 10-26-79

PROJECT FEATURE

NAME J. Bilotta

DISCIPLINE

NAME S. Knight

NAME G. Castro

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	Good condition at end of outlet pipe.
Rust or Staining on Concrete	None.
Spalling	None.
Erosion or Cavitation	None.
Cracking	None.
Alignment of Monoliths	None.
Alignment of Joints	None.
Numbering of Monoliths	None.

INSPECTION CHECK LIST

PROJECT East Long Pond

DATE 10-26-79

PROJECT FEATURE

NAME J. Bilotta

DISCIPLINE

NAME S. Knight

NAME G. Castro

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE OUTLET CHANNEL	No outlet structure as such.
General COndition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Conditon at Joints	
Drain holes	
Channel	
Loose Rock or Trees Overhanging Channel	No loose rock, some trees.
Condition of Discharge Channel	Narrow by in good condition.

INSPECTION CHECK LIST

PROJECT East Long Pond

DATE 10-26-79

PROJECT FEATURE

NAME J. Bilotta

DISCIPLINE

NAME S. Knight

NAME G. Castro

AREA EVALUATED	CONDITIONS	
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNEL	Service Spillway 0.8' higher	Emergency Spillway
a. Approach Channel	None	
General Condition	None.	silted (riprap left side only)
Loose Rock Overhanging Channel	None	
Trees Overhanging Channel	None	
Floor of Approach Channel		-clogged with debris
b. Weir and Training Walls		No training walls
General Condition of Concrete	Good	Good
Rust or Staining	Minor	Minor
Spalling	Minor spilling	None observed
Any Visible Reinforcing	None observed	None observed
Any Seepage or Efflorescence	None observed	None observed
Drain Holes	None observed	None observed
c. Discharge Channel		
General Condition	Good*	Good
Loose Rock Overhanging Channel	None	None
Trees Overhanging Channel	Some	None
Floor of Channel	Rock, boulders & outcrops	Cobbles
Other Obstructions	None	None Seepage observed at bottom of discharge spillway -rust stained
*Severe spalling of downstream face		

INSPECTION CHECK LIST

PROJECT East Long Pond

DATE 10-26-79

PROJECT FEATURE

NAME J. Bilotta

DISCIPLINE

NAME S. Knight

NAME G. Castro

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	None
a. Super Structure	
Bearings Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Conditon of Seat & Backwall	

APPENDIX B

ENGINEERING DATA

APPENDIX B

1. Records of design and construction that occurred during 1929 and 1930 are available on microfilm in the Vermont State records. They have been photocopied and placed immediately behind this page.

2. Inspection reports were filed by Stephen Haybrook for the Public Service Commission and by Don Speis and A. Peter Barranco for the Vermont Department of Water Resources. Photocopies of some of the available literature follow. The inspection reports are available in the Montpelier, Vermont, office of the Department of Water Resources.

3. Plans and sketches prepared by DuBois & King, Inc., appear on figures B-1 and B-2. Information shown on these plans and sketches is based upon information in past inspection reports and observations made duringthe visual inspection. Dimensions or materials indicated on these plates which were below grade or water during the time of inspection were not verified. Elevations shown are based upon USGS datum.

4. There are no known records of subsurface investigations.

VERMONT PUBLIC SERVICE COMMISSION
NOV 7 1929
RECEIVED

GENERAL SPECIFICATIONS

EAST LONG POND DAM - W.O. #79

GREEN MOUNTAIN POWER CORPORATION

The word 'engineer' as used herein shall be construed to mean the Trojan Engineering Corporation or its authorized representative.

Drawing #M-79-1 shall be included as a primary part of these specifications.

The masonry work required at the spillway section, shall, unless otherwise prescribed by the engineer, be constructed as shown on the plans. It is possible that certain field instructions will be necessary.

The base area of the earth dam shall be cleared of all debris including trees, stumps, sod and weeds. The stumps shall be entirely removed from the ground and placed below the downstream toe of the dam.

The earth embankment shall be constructed by the rolled fill method. All filling material will be dumped over the area and spread in layers approximately 8" thick. Each layer shall be well dampened and rolled over the entire area with a roller of such weight that the pressure is at least 50 pounds per square inch.

All nests of stones shall be separated. The stones larger than 6" or 10" shall be removed from the filling material and placed as riprap.

The upstream and downstream rock toes of the earth embankment shall be constructed as shown on the drawings and preferably before placing embankment material.

An impervious material shall be used for core purposes and shall, unless otherwise prescribed by the engineer, be placed in the center of the dam. This core shall extend from the bottom of the cut-off trench to the top of the dam, and shall, in the highest part of the structure, be approximately 10' wide at the base, tapering to a width of 3' at the top. If an abundance of impervious material is available, then the entire upstream portion of the embankment may be constructed for cut-off or core purposes.

As shown on the plans, a portion of the earth embankment base area shall be stripped of all vegetation and loamy material.

At the completion of the work, the top and downstream face of the embankment shall be seeded with a mixture of timothy and rye. The completed work as a whole, must be indicative of good craftsmanship. All remaining debris and left-over material shall be removed from the site to some point.

By _____

Approved _____

New York City
Sept. 25, 1929.

Typed: JP/AL/1-5
Typing Checked _____

H. K. BARROWS
M AM SOC C E
CONSULTING ENGINEER
6 BEACON STREET
BOSTON

RICHARD S. HOLMGREN
M AM SOC C E
PRINCIPAL ASST ENGINEER

August 30, 1930

Hon. Henry B. Shaw, Chairman
Public Service Commission
Montpelier, Vermont

No.1563 - East Long Pond Dam

Dear Sir:

In accordance with the order of your Commission dated Nov. 19, 1929, I submit the following report upon the dam constructed at East Long Pond outlet, in the town of Woodbury, Vt., during the latter part of 1929.

DESCRIPTION (See plan L-79-1)

The East Long Pond Dam of the Green Mt. Power Corporation is located in the town of Woodbury upon a small stream which flows northerly and enters the Lamoille River at Hardwick. East Long Pond and Nichols Pond, a short distance downstream, furnish storage for the Hardwick plant of the Green Mt. Power Corporation.

The tributary drainage area at East Long Pond is about 8 square miles and it has a water area of about 250 acres.

The dam is constructed of rolled earth fill about 250 ft. long, with a short section of concrete spillway and a 2 - 2.5 x 3' outlet gate near the middle of the dam and a 1[illegible] ft. low concrete wall, [illegible] at a bend easterly a short distance from the dam, [illegible] crests at El. [illegible].

The maximum height of dam is about 12 ft. and it is founded upon impervious material.

The earth embankment is 1 ft. wide on top at El. [illegible] and has a slope on the water side with 12" riprap on the water slope, and is about 8' in maximum height. It is built with a central core of clay about 10 ft. thick at the top and [illegible]

with cutoff ditch 2 ft. deep x 5 ft. wide; the remainder of the cross-section is of a mixture of clay and sand and gravel, with coarse material at the outside portions and rock fill at downstream toe.

The top of the earth embankment as shown on the plan is at El. 103.5. This level was raised by my direction to El. 104.75 in order to give a safe freeboard for the earth embankment.

The short concrete spillway (about 10 ft. long) at El. 100.75 is constructed by raising and extending the stone masonry side walls of an old spillway; the auxiliary spillway, also at El. 100.75, is formed of a block of concrete 18" thick set 2 ft. into the ground and backed with stone fill. There are 2 - 2½ x 6 ft. outlet gates located at the small spillway section.

INVESTIGATIONS

In the Field. Before receiving your order, construction, which began during October, had already proceeded to the extent of the concrete spillways and part of earth embankment.

Nov. 23,1929. Visited job with Mr. E. C. Clysson, engineer in charge, and suggested several changes in method of construction, including

(1) Increase in level of earth embankment to El. 104.75, to give greater freeboard, as already noted.

(2) Use of clay for central core only and of some sand and gravel in outer sections of embankment.

(3) Constructing a concrete cutoff wall on each side of the wing walls of dry rubble at the short spillway.

(4) Directions were also given as to use of no frozen fill and submission of copies of inspector's weekly reports.

Dec. 18,1929. Visited job with Mr. P. A. Chew of Arojan Engineering Corporation (who constructed the work) and Mr. E. C. Clysson. Work was nearly completed; inspected fill by drilling holes and found that top had been raised as required.

Office Work. This included study to check spillway capacity and general arrangement. These are adequate.

CONCLUSIONS AND RECOMMENDATIONS

This small structure was constructed under some difficulties due to its isolated location, but its method of construction is satisfactory and in my judgment it provides adequately for the public safety and its manner of construction is satisfactory.

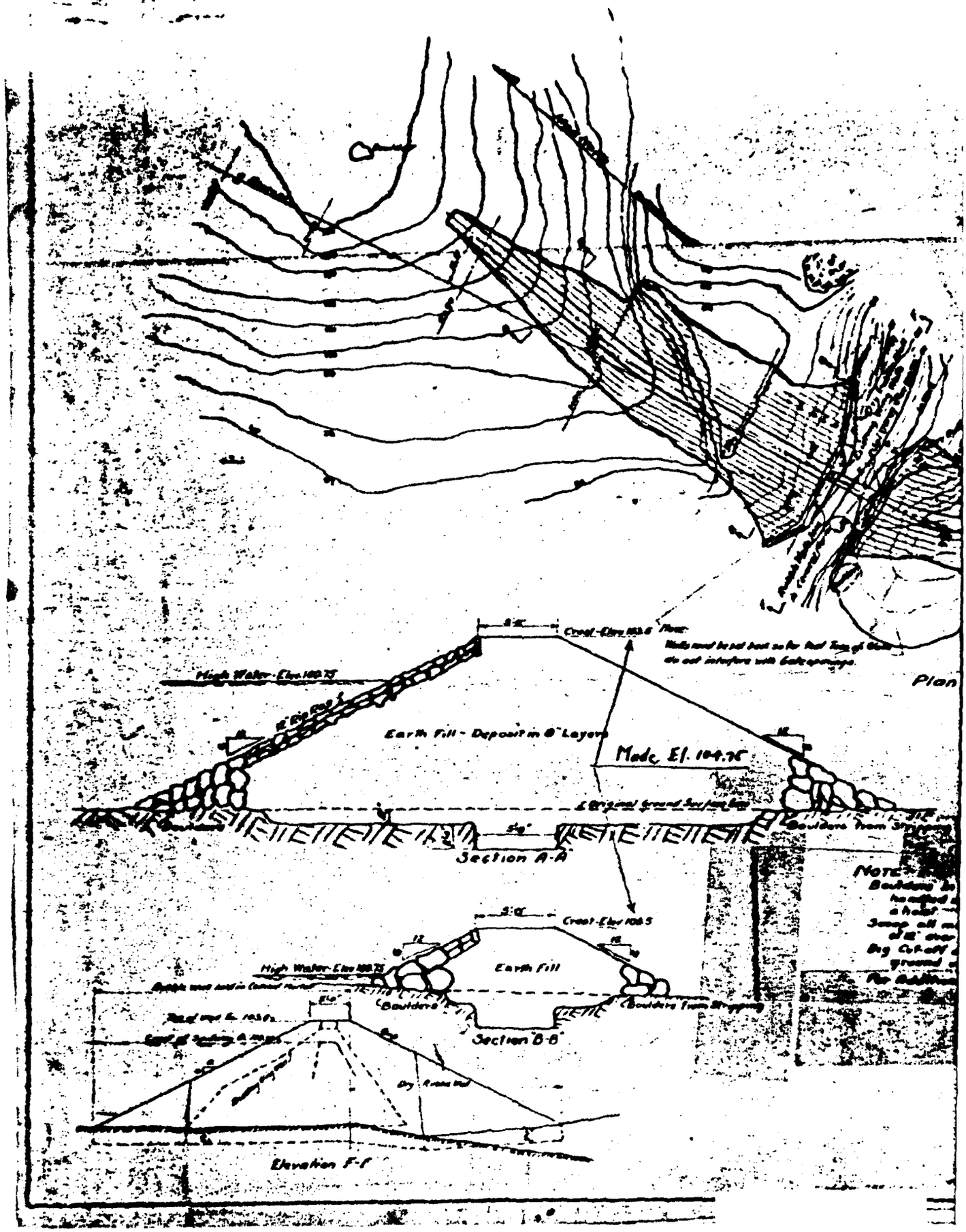
Acknowledgments are made to the engineers of the Trojan Engineering Corporation for assistance and courtesies rendered.

Respectfully submitted,

H. D. Gallaher

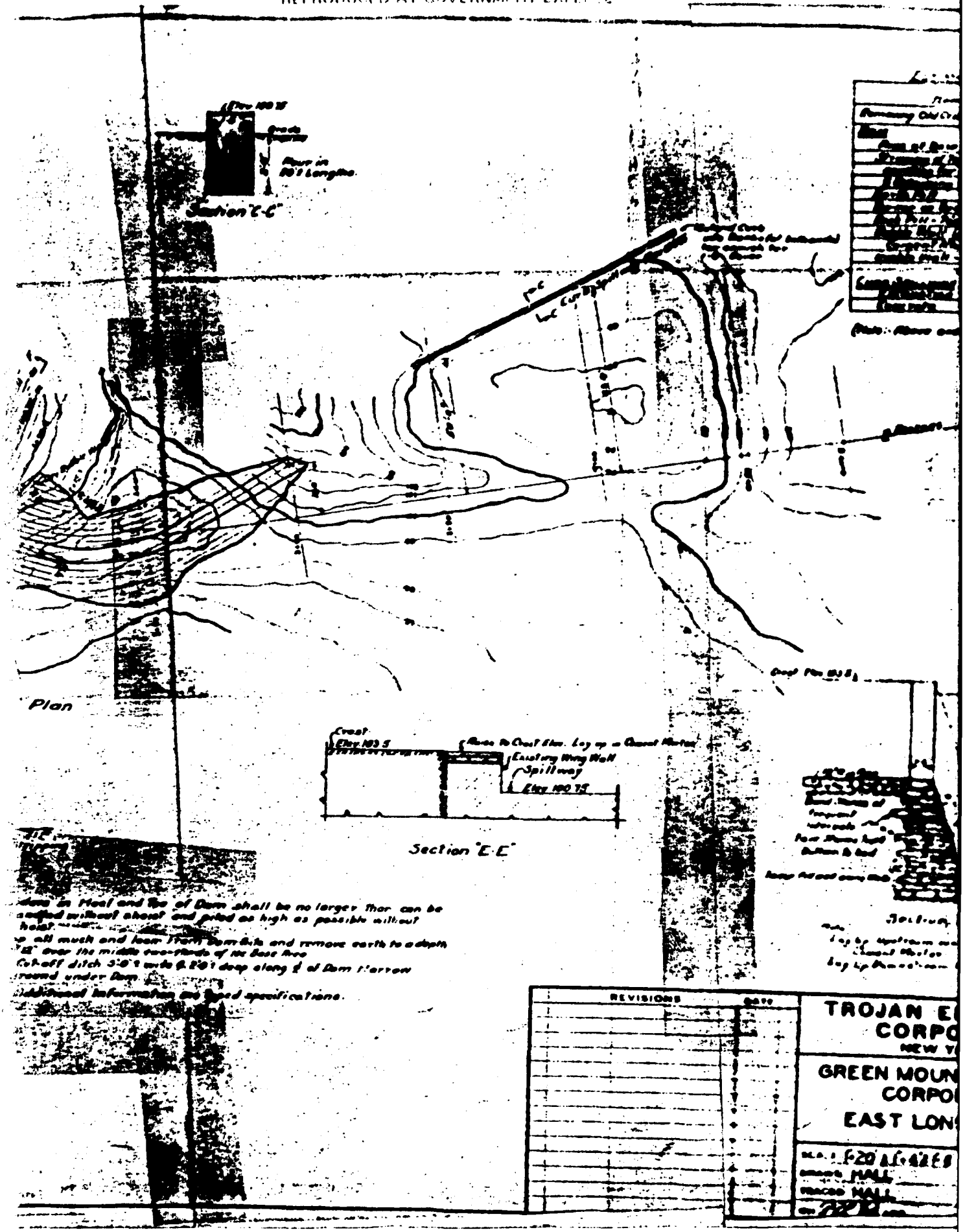
Accompanied by

Plan M-79-1



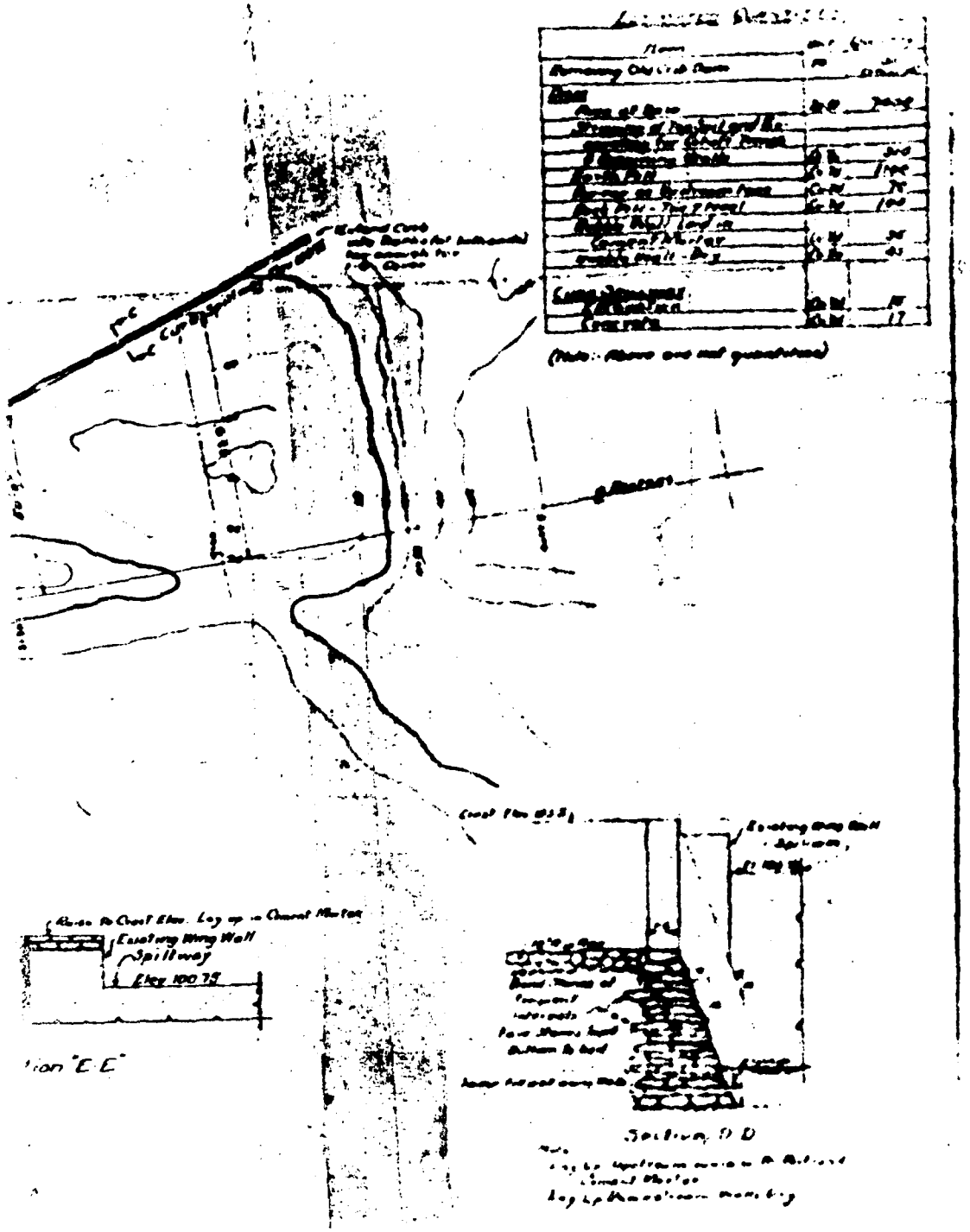
Reproduced from best available copy.

REPRODUCED AT GOVERNMENT EXPENSE



273

REPRODUCED AT GOVERNMENT EXPENSE



REVISIONS	DATE

TROJAN ENGINEERING CORPORATION
NEW YORK

GREEN MOUNTAIN POWER CORPORATION

EAST LONG POND DAM

SCALE 1"=20' & 1"=4' & 1"=8'	DATE 9-12-29
DESIGNED HALL	JOB NO 79
TRACED HALL	M-701
CHK'D [illegible]	

DAM INSPECTION STATUS

Name EAST LONG POND
Town Woodbury
Owner Village of Hardwick (Elastic Dept.)
Address Hardwick, Vt.
Telephone 472-5201 (Supt. Village Elec. Dept.)

DWR No. 252-2
NDS No. VT00 185
Hazard Class 2 *
Size Category II
Inspect every N/R years **

Type EF Height 20' Storage 1700# Use P(S) Juris. PSB

** Not required because of PSB jurisdiction. DWR inspects when in the area on referred basis.

INSPECTION RECORD

Inspection Date	Inspected By	Report Date	Owner Notified	Condition Summary
6-9-49	SHH (PSC)	10-27-49		Fair-Good. Needs maintenance, repair
5-9-53	SHH (PSC)	5-9-53		Fair-Poor. Needs maintenance, repair
7-27-73	DHS (DWR)	7-27-73		Fair-good. Erosion (E/S) Needs maintenance
8/2/73	DHS+COE	8-2-73	8-2-73	Erosion A/S E/S. (FDAA? DSR INSPECTION)
7-16-74	DHS (DWR)	—		Flood damage in E/S channel repaired
7-23-79	MPB (DWR)	8-11-79		Fair-Good. Need maintenance

POTENTIAL DOWNSTREAM HAZARDS

Description	Miles Downstream	Remarks
Nichols Pond Dam	0.9	Subject to overtopping by E. Long Pd Dam
Mackville Pond Dam	3.4	" " " E. Long & Nichols
Mackville (village)	3.5-4.0	Town road, houses (?), power-plant
Route 14 (Hardwick)	40	Bridge, travelers (?)

* Hazard Class 2 based on possible overtopping and failure of lower dams.

INFORMATION AVAILABLE

Plans _____ Dimensions (field check) 7-23-79 Photos 1973, 1974, 1979

INFORMATION NEEDED NEXT INSPECTION

Dimensions (field check) _____ Detailed Survey _____ Photos ✓
Other _____

DWR 4/79

Utilities : Electric Plants : Power

REPORT

EAST LONG POND DAM

East Long Pond Dam is located at the pond outlet in the town of Woodbury, Vermont. It is owned by the Village of Hardwick and operated as a storage reservoir for hydro-electric plants further downstream.

The tributory drainage area to the dam is about 3 square miles. At full pond level the dam impounds a reservoir having a surface area of about 250 acres and a useable volume of about 43 million cubic feet.

This dam was constructed in 1929-30 under Public Service Commission supervision (Case No. 1563). Mr. H. K. Barrows, Consulting Engineer, was supervising engineer for the Commission. At time of construction, the dam was owned by the Green Mountain Power Corporation.

General Description:

Details of the dam are contained in Mr. Barrows' report of August 30, 1930. In general, the dam is constructed of rolled earth fill of selected materials and is about 250 feet long and 12 feet high. In cross-section, it has a top width of about 5 feet and side slopes on both faces of 1-on-2. Through its middle, at the maximum section, is a short masonry spillway section which also contains two 2.5-feet-by-six-feet outlet gates. At a sag in the rim of the reservoir, near the east end of the dam, is an auxiliary spillway consisting of a concrete wall 100 feet long and 2.0-feet-by-1.5-feet in cross-section.

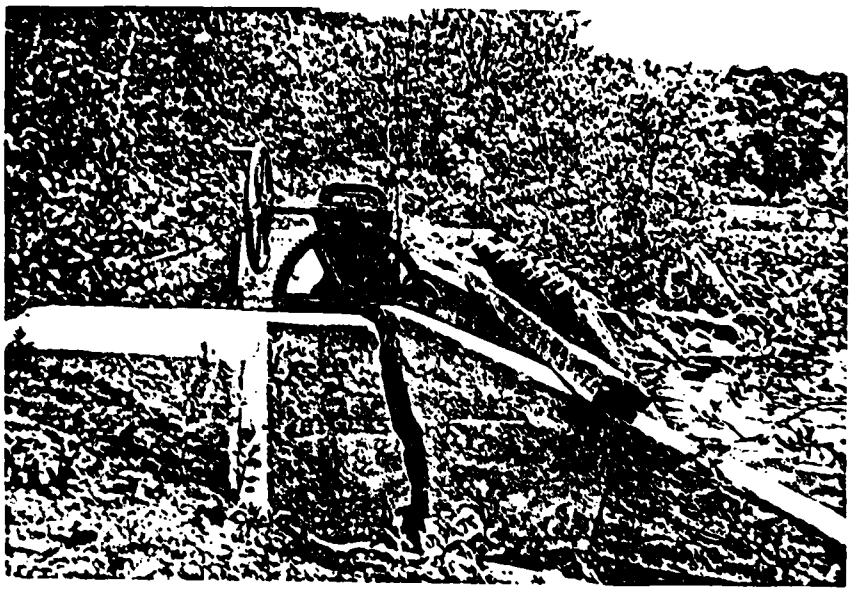
Condition of Dam:

When viewed by the writer on June 9, 1949, the condition of the dam was noted as follows:

Since completion of the embankment some settlement with consolidation has occurred. The top of the dam has lowered probably one foot to 1.5 feet

but is still high enough for the existing spillway crest level. The embankment appeared in a stable condition. All exposed faces of the embankment have now become overgrown with brush, which adds somewhat to holding it together although it does indicate a lack of maintenance. Seepage was detected along the west wing wall of the spillway and gate section, indicating an insecure bond between the wall and the embankment. However, at its present stage, the condition is not serious.

Settlement has also occurred in the spillway and gate section, resulting in a crack in the west wing wall, indicated in the photograph below. The separation at the top measures about 5 inches. The condition, however, does not adversely affect the stability of the section at this time. It is noted that the wing wall construction consists of a concrete extension, built on an existing stone masonry wall.



Spillway and Gate Section of East Long Pond Dam, Equipped with Timber Trash Rack.

(Note settlement crack in wing wall. Also note overgrowth on earth embankment.)

The concrete wall, serving as an auxiliary spillway, was found to be in a run-down condition. Deep cracks in the concrete permitted leakage in a few places. Some surface scaling has also taken place. Because this section is backed by a stone fill and because the depth of water is shallow at this location, it is considered stable enough.

Comments:

According to Mr. Barrows' report, the construction of this dam was carried out in a satisfactory manner. Some changes in the design, as suggested by him, were incorporated in the construction. The most significant of these is the additional foot of embankment to provide sufficient freeboard after settlement and the use of clay for the central core.

East Long Pond discharges into Nichols Pond which is located about ½ mile further downstream. Both are about equal in size in storage capacity and are situated in an isolated, wooded location. Nichols Pond has a retarding effect on any large discharge released from East Long Pond.

The owner is now in the process of building an access road to the dam site. Its purpose is to facilitate maintenance and repairs. Plans to repair the dam are under consideration.

Conclusions:

In view of its location, East Long Pond Dam is believed to be in a reasonably good condition.

Stephen H. Haybrook

STEPHEN H. HAYBROOK
HYDRAULIC ENGINEER

Public Service Commission
Montpelier, Vermont
October 27, 1949

REPORT NO. 78

STATE OF VERMONT

AGENCY OF ENVIRONMENTAL CONSERVATION

Department of Fish and Game
Department of Forests, Parks, and Recreation
Department of Water Resources
Environmental Board
Division of Environmental Engineering
Division of Environmental Protection
Natural Resources Conservation Council

Montpelier, Vermont 05602
Department of Water Resources

WATER QUALITY DIVISION

October 12, 1979

M E M O R A N D U M

To: *File*

From: *A. Peter Barranco, Jr., P.E., Dam Safety Engineer*

Subject: *East Long Pond Dam - Woodbury (252-2)*

On July 23, 1979 the writer inspected subject dam and obtained dimensions and photographs. Water level - 1.75' below P/S crest.

The dam appears to be in fair-good condition but in need of maintenance principally brush and tree removal. The concrete of the spillway is in generally good condition, however, there is deterioration of concrete facing downstream. Active seep in right downstream stone side wall for spillway channel. No apparent seepage along downstream toe, however, it was so overgrown with brush that it was difficult to examine closely.

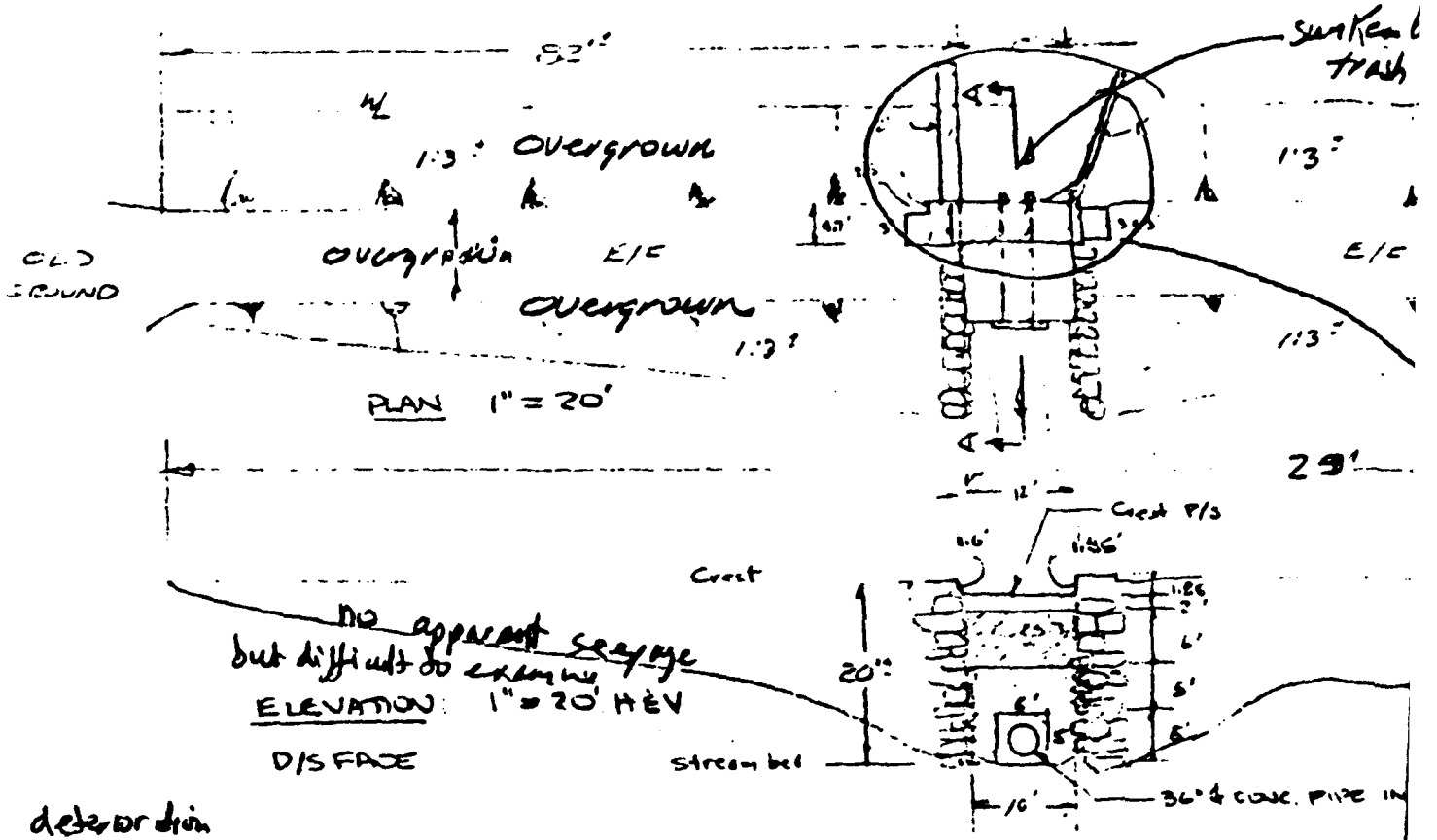
Emergency spillway has collected some debris on weir and approach channel. Weir is partially buried and overgrown. Cobble riprap protection in exit channel in fair shape. Seepage noted below weir in cobbles. Some sunken barrels have lodged against the trash rack at the principal spillway.

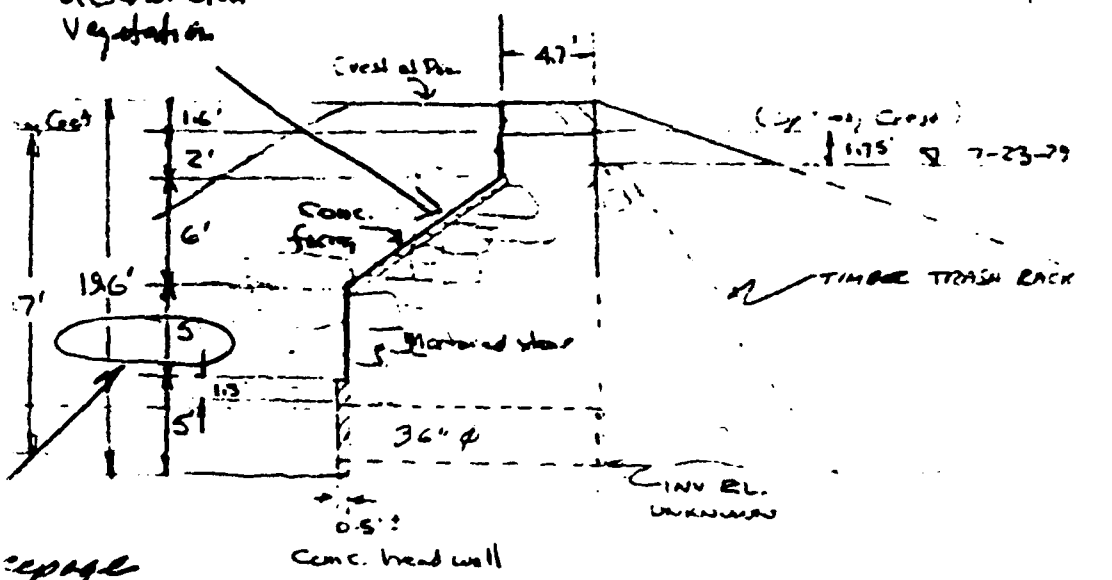
vl

REPRODUCED AT GOVERNMENT EXPENSE

DATE

JOB NO



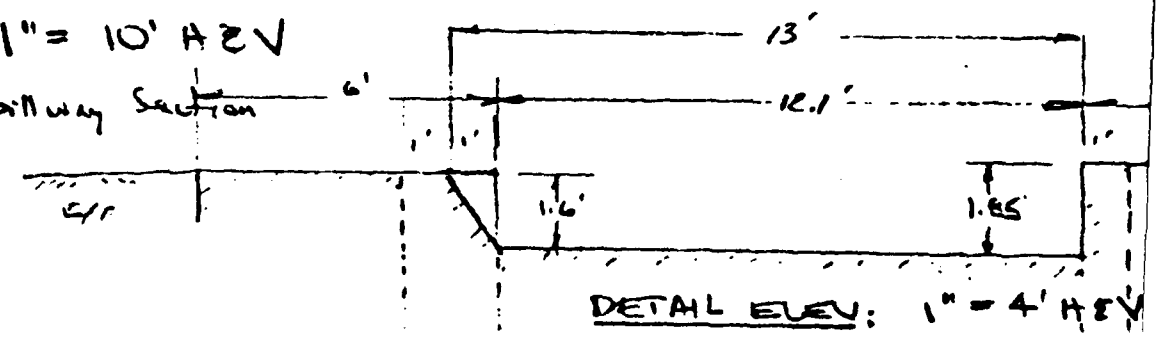


Seepage

#79-25-21 Section A-A

1" = 10' H&V

Spillway Section

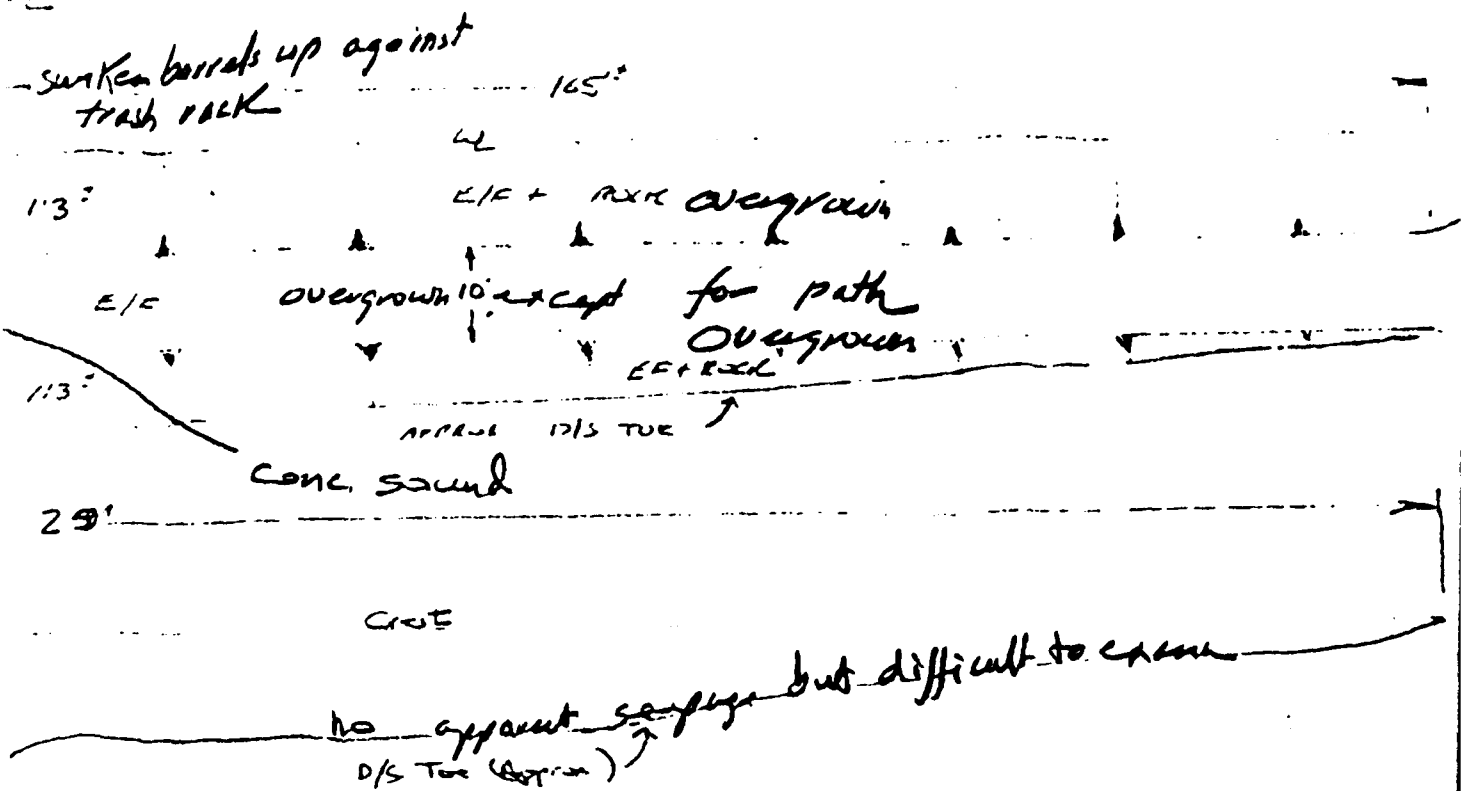


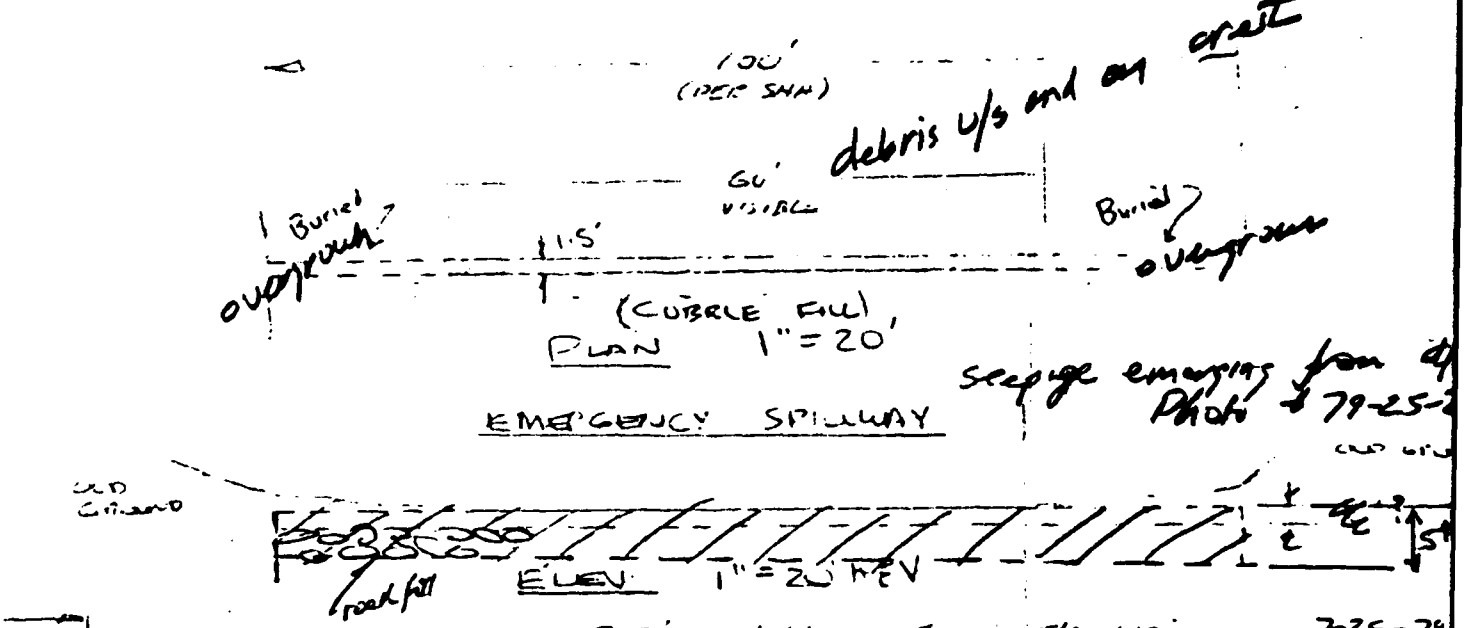
DETAIL ELEV: 1" = 4' H&V

D/S SPILLWAY

Reproduced from best available copy.

REPRODUCED AT GOVERNMENT EXPENSE

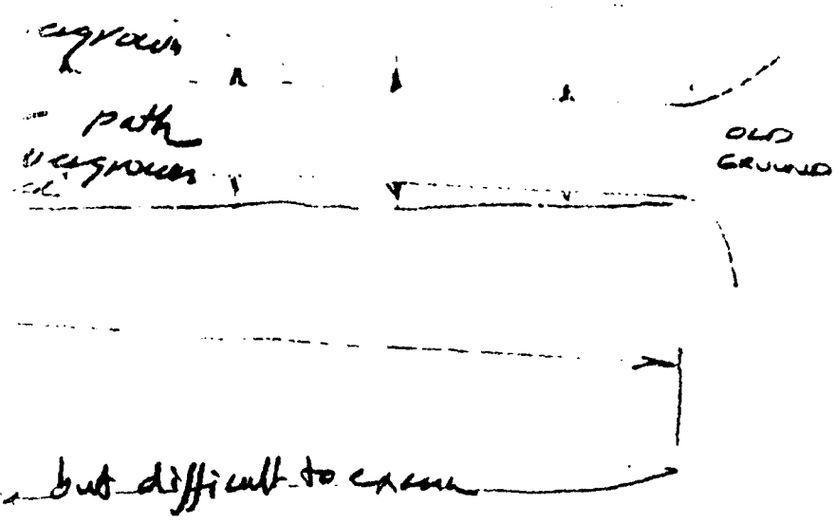




Inspection / Survey 7-23-79 APB
Hand level, 6' rule & c
Clear ESO?

7-23-79
Notes

REPRODUCED AT GOVERNMENT EXPENSE



but difficult to excav

debris u/s and on crest

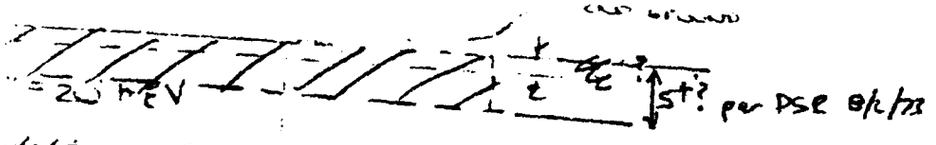
Buried?

overgrown

E FULL)
1" = 20'

SPILLWAY

seepage emerging from d/s rip rap
Photo # 79-25-23



u/s/e crest of d/s weir on 7-25-79

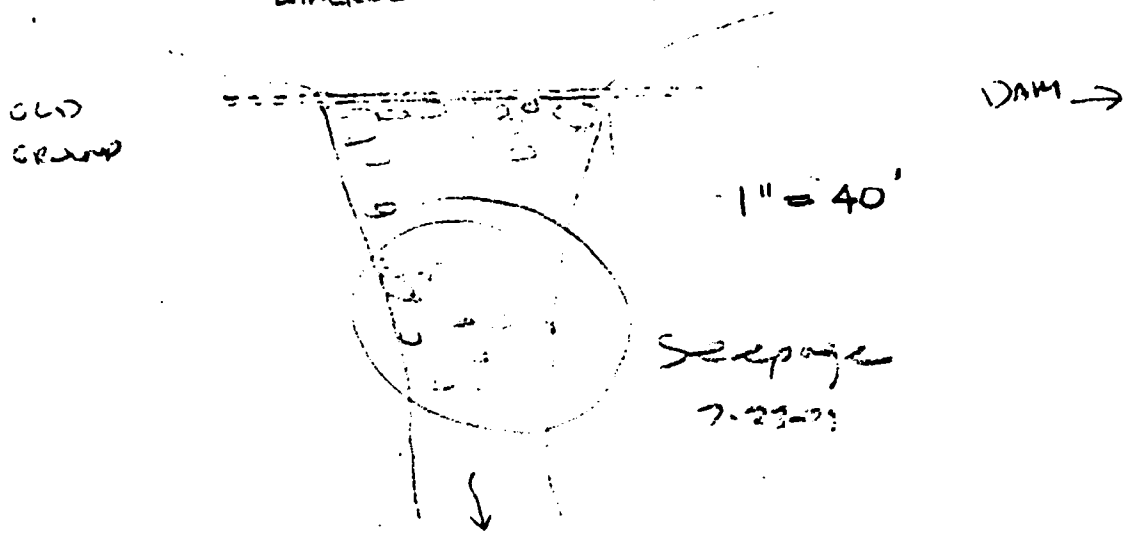
Inspection / Survey 7-23-79 RPB
Hand level, 6' rule & cloth tape
7-23-79
Notes Clear ESE

BY APB DATE 10-2-79 SUBJECT LAST LONG ISLAND DAM
Woodbury

CHKD. BY DATE

SHEET NO. 2 OF 2
JOB NO. 252-2

EMERGENCY SPILLWAY



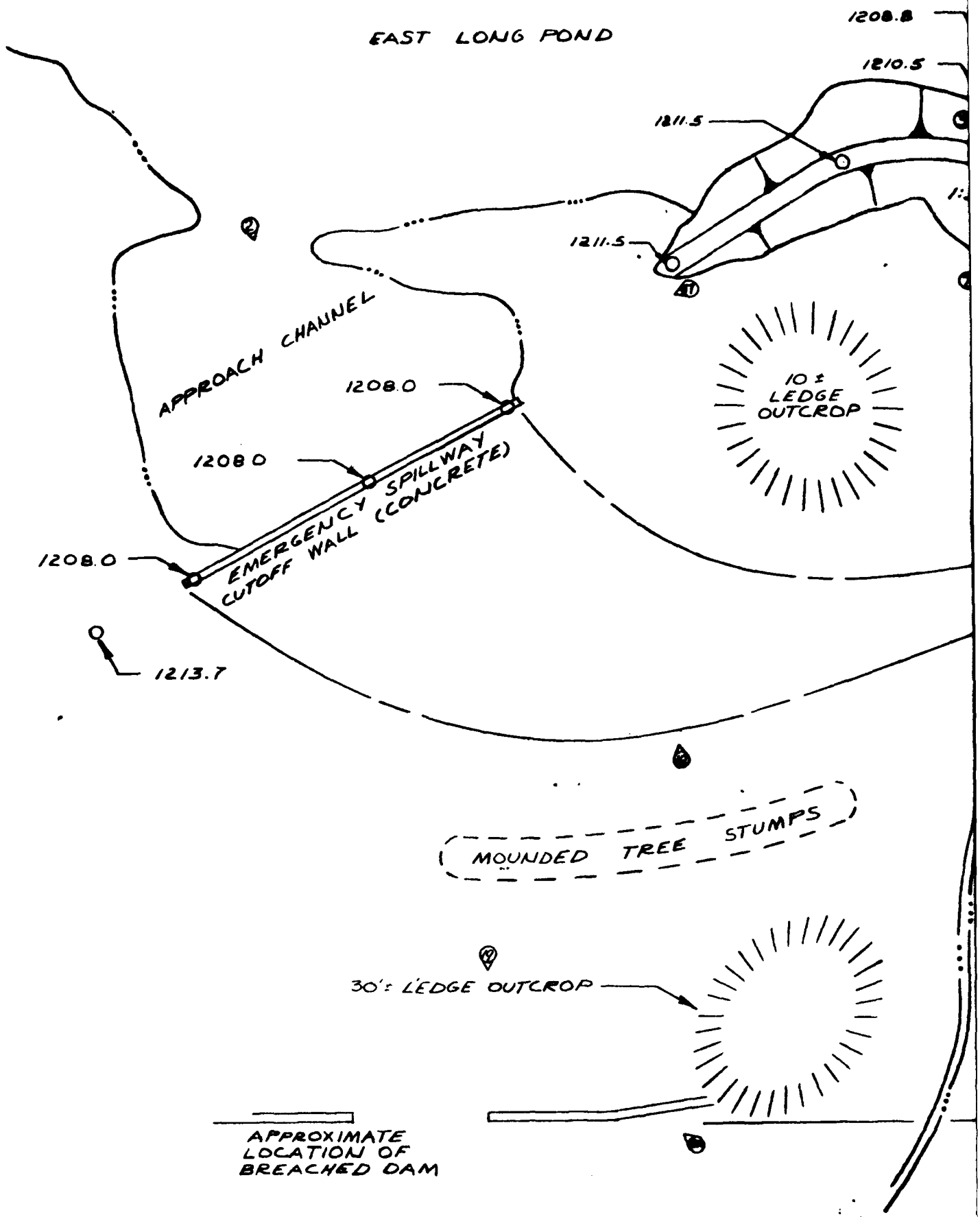
EAST LONG POND

JULY 16, 1974

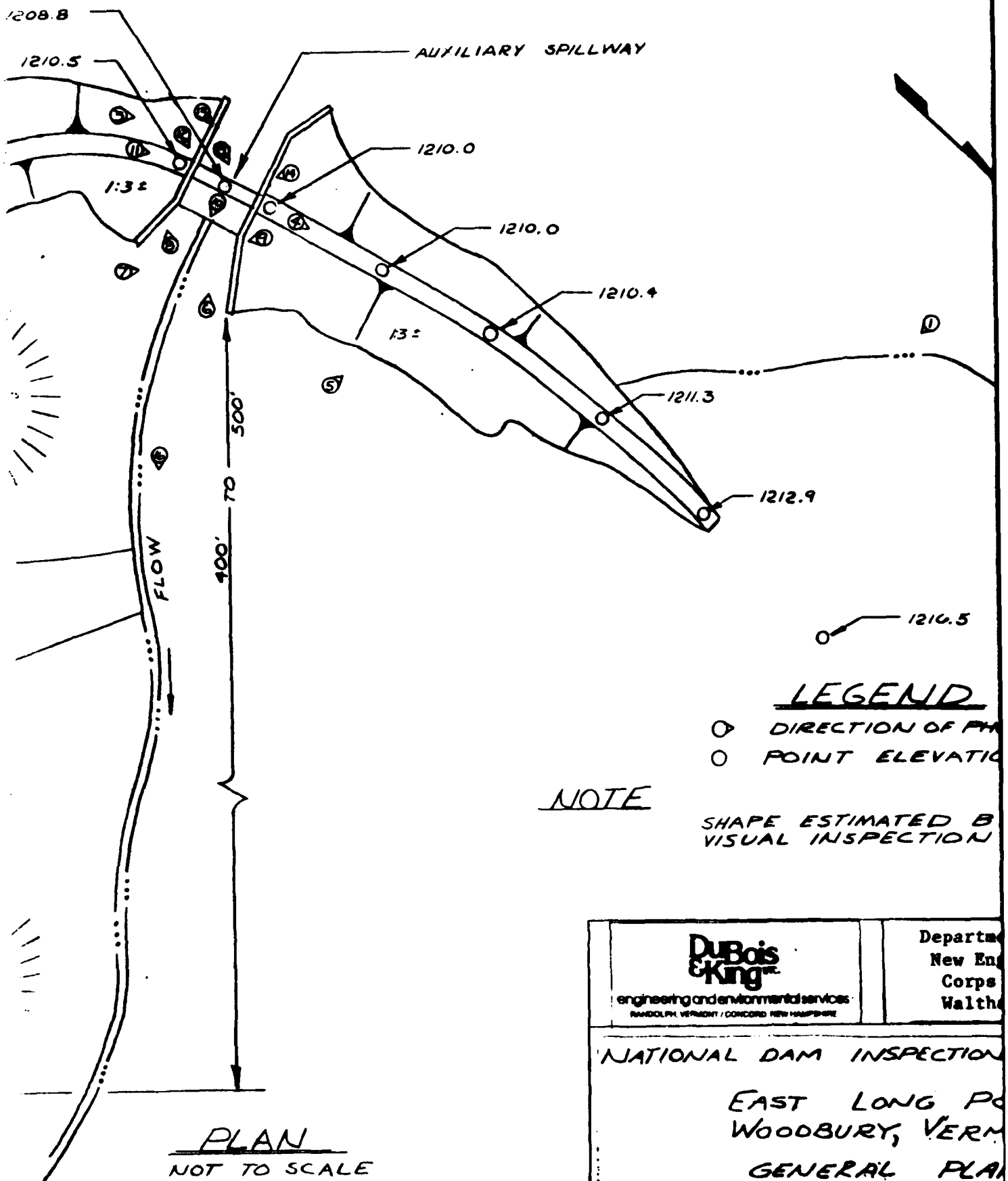
REPAIRS TO EMERGENCY SPILLWAY EXIT CHANNEL

(REPLACED STONEFILL & REPAIR OF EROSION DAMAGE FROM 1973 FLOOD)

REPRODUCED AT GOVERNMENT EXPENSE



REPRODUCED AT GOVERNMENT EXPENSE



PLAN
NOT TO SCALE

DuBois & King Inc.
engineering and environmental services
RANDOLPH, VERMONT / CONCORD, NEW HAMPSHIRE

Departm
New En
Corps
Walth

NATIONAL DAM INSPECTION

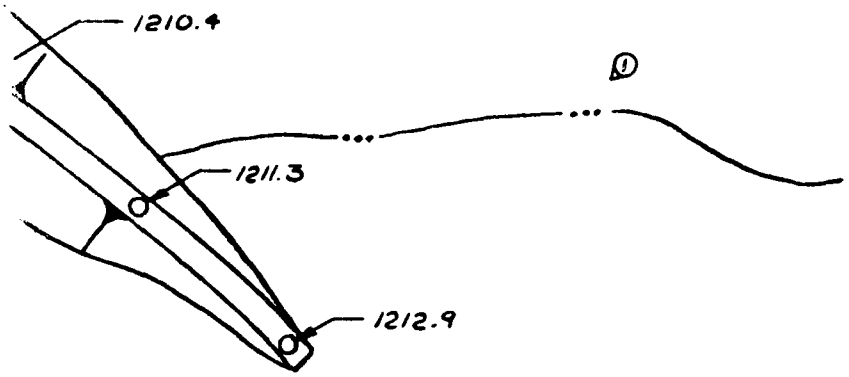
EAST LONG P
WOODBURY, VERM
GENERAL PLA

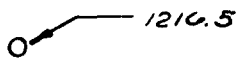
DRAWN CHECKED APPROVED PL

REPRODUCED AT GOVERNMENT EXPENSE

Y SPILLWAY

10.0





LEGEND

- DIRECTION OF PHOTOGRAPHS
- POINT ELEVATION

NOTE

SHAPE ESTIMATED BY VISUAL INSPECTION

DuBois & King Inc.
engineering and environmental services
RANDOLPH, VERMONT / CONCORD, NEW HAMPSHIRE

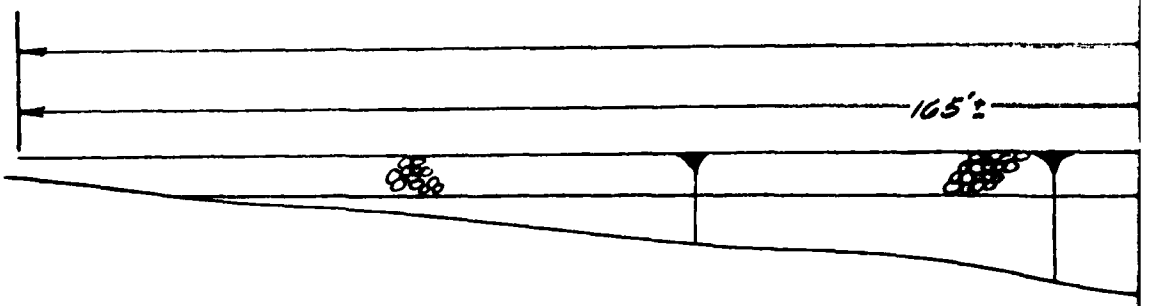
Department of the Army
New England Division
Corps of Engineers
Waltham, MA 02154

NATIONAL DAM INSPECTION PROGRAM

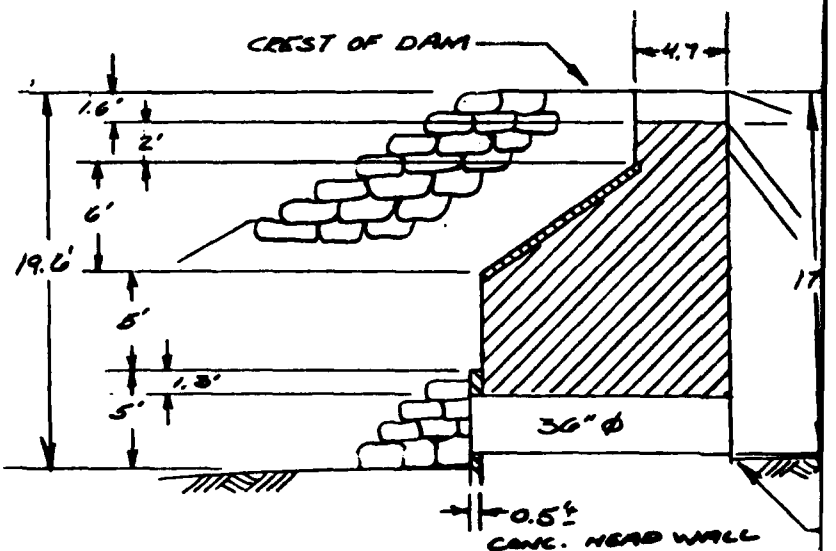
EAST LONG POND DAM
WOODBURY, VERMONT
GENERAL PLAN

DRAWN	CHECKED	APPROVED	PLATE NO.
			B-1

REPRODUCED AT GOVERNMENT EXPENSE

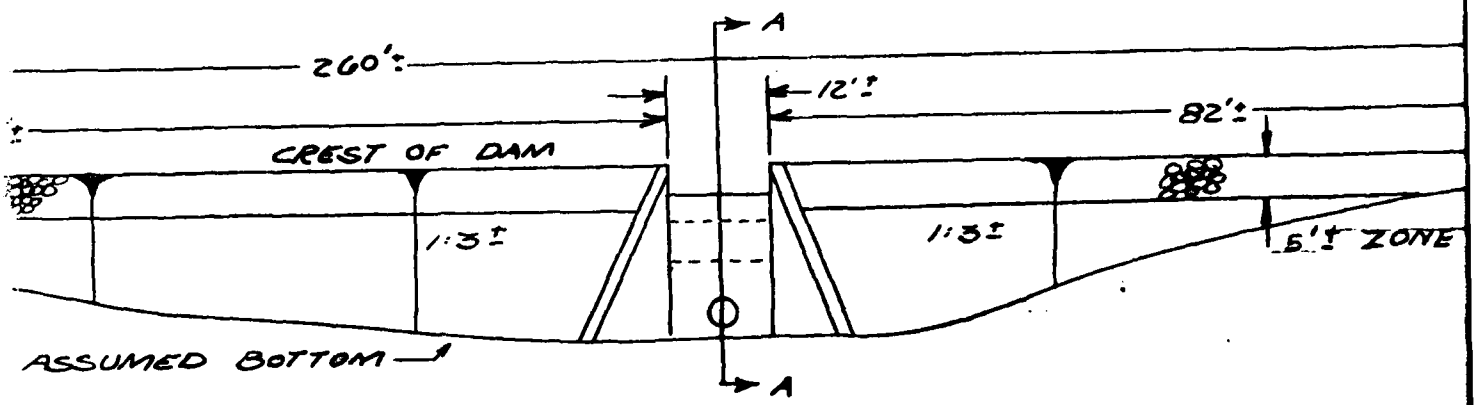


ASSUME

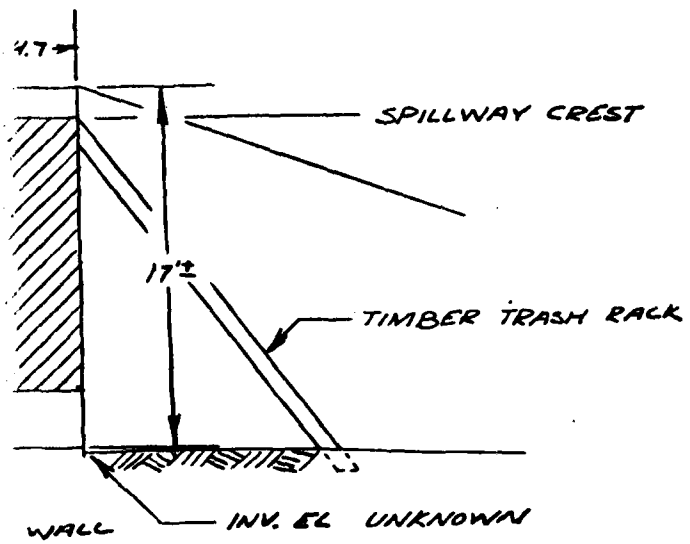


SECTION A-A
NOT TO SCALE

REPRODUCED AT GOVERNMENT EXPENSE



ELEVATION
NOT TO SCALE
LOOKING DOWNSTREAM



A
NTS

DuBois & King Inc.
engineering and environmental services
RANDOLPH, VERMONT / CONCORD, NEW HAMPSHIRE

Depar
New
Cor
Wa

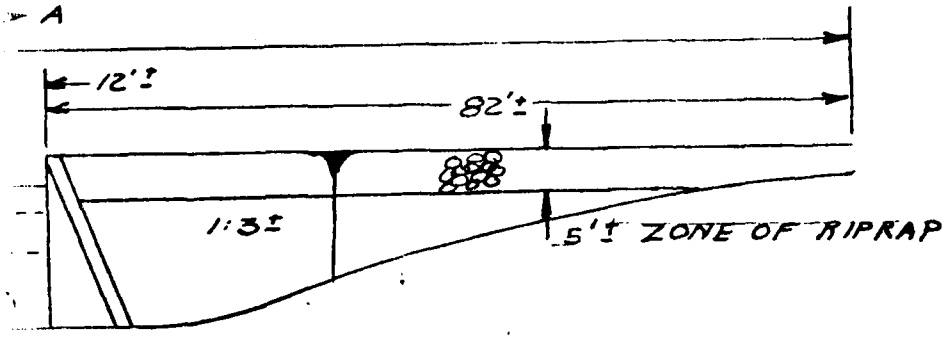
NATIONAL DAM INSPECTI

EAST LONG
WOODBURY, VE

ELEVATION AND

DRAWN	APPROVED	REVIEW	SCALE
JAS	RMC		DATE

PL



N
SLE
UNSTREAM

DuBois & King Inc. engineering and environmental services RANDOLPH, VERMONT / CONCORD, NEW HAMPSHIRE	Department of the Army New England Division Corps of Engineers Waltham, MA 02154

NATIONAL DAM INSPECTION PROGRAM

EAST LONG POND DAM
WOODBURY, VERMONT
ELEVATION AND SECTION

DRAWN	APPROVED	REVIEW	SCALE: AS SHOWN
JAS	RMC		DATE: DECEMBER 20 1979

PLATE B-2

APPENDIX C

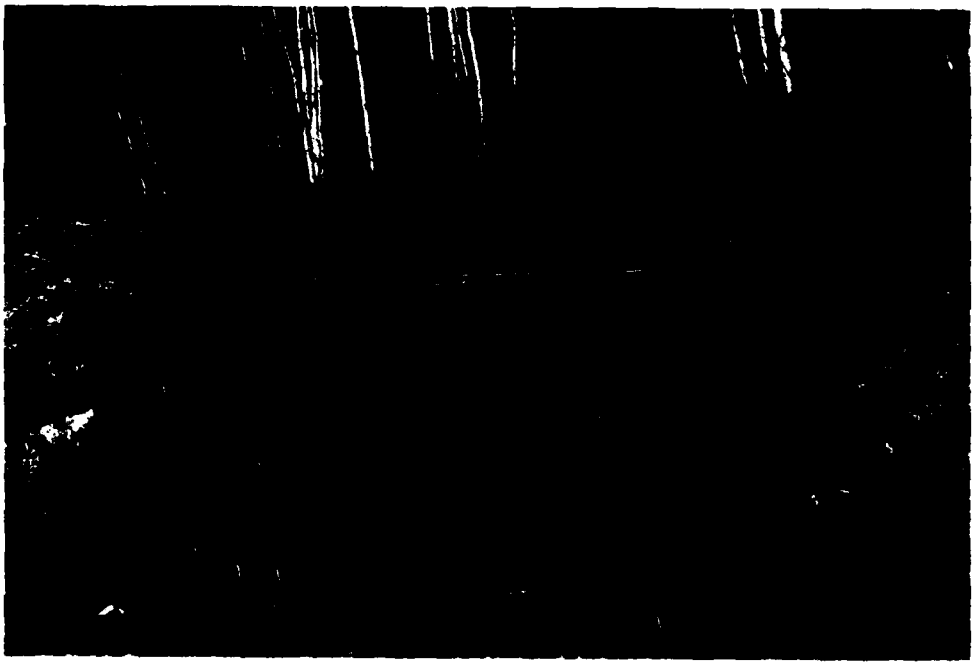
PHOTOGRAPHS

FOR LOCATION OF PHOTOS, SEE FIGURE B-1
LOCATED IN APPENDIX B

1. Upstream face of dam

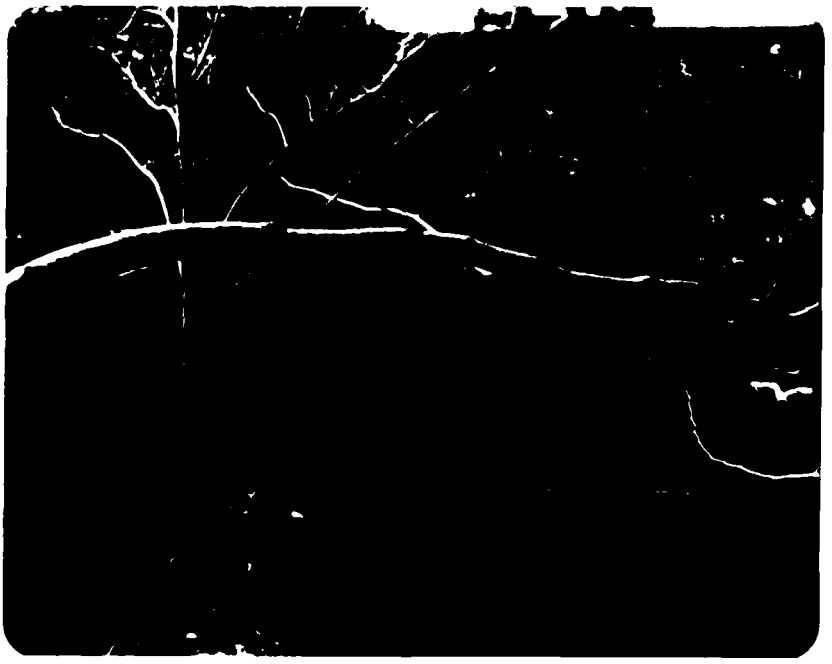
2. Upstream approach to Emergency Spillway

3. Upstream slope left of Auxiliary Spillway



4. Crest of dam left of Auxiliary Spillway

5. Downstream slope, left of Auxiliary Spillway

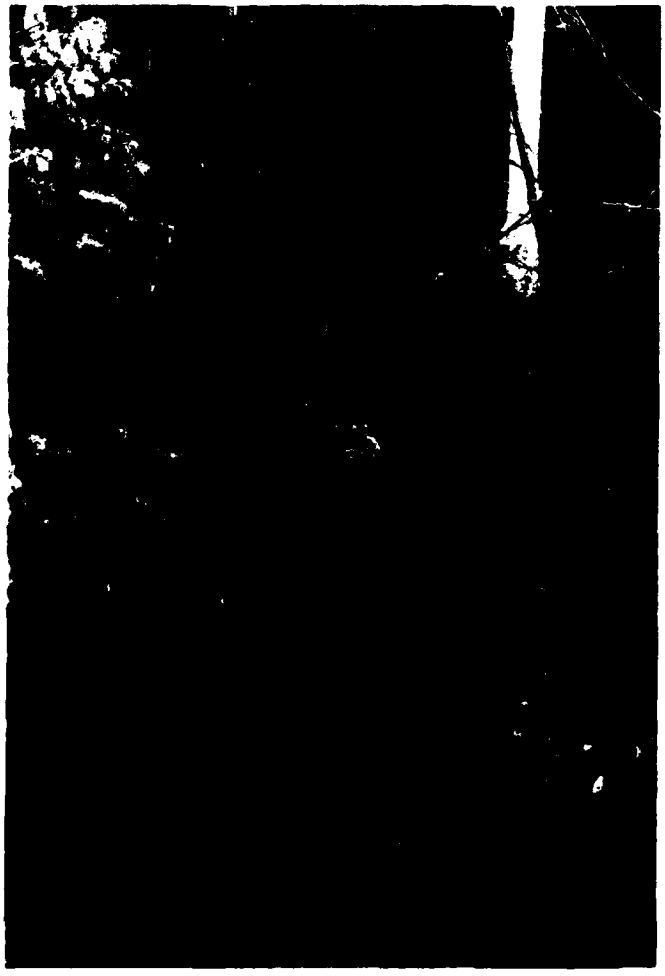


6. Downstream face of Auxiliary Spillway

7. Seep at base of right training wall

8. Left training wall

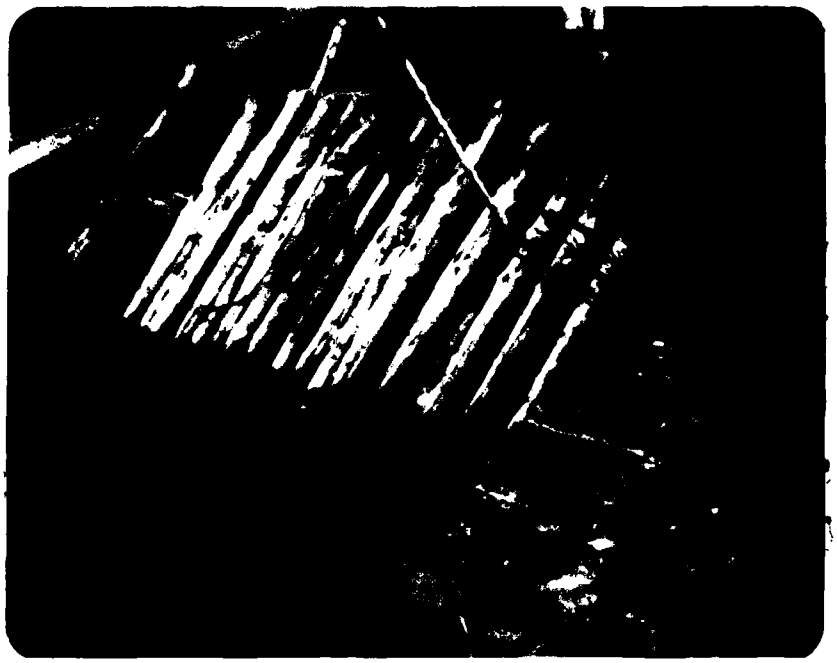
9. Right training wall



10. Exit channel for Auxiliary Spillway, looking downstream

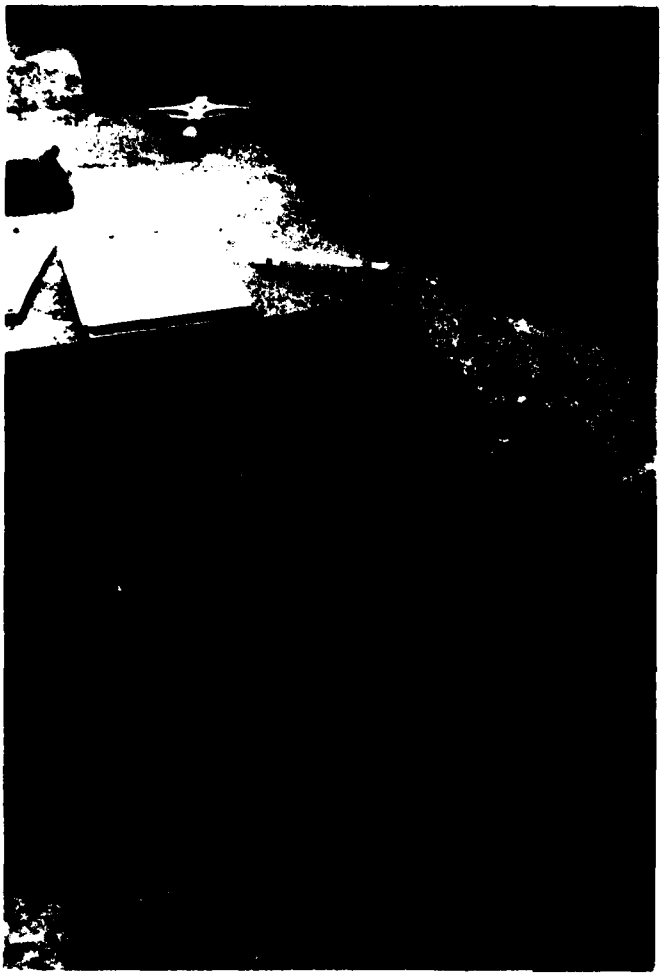
11. Gate operating mechanism

12. Base of gate operating mechanism



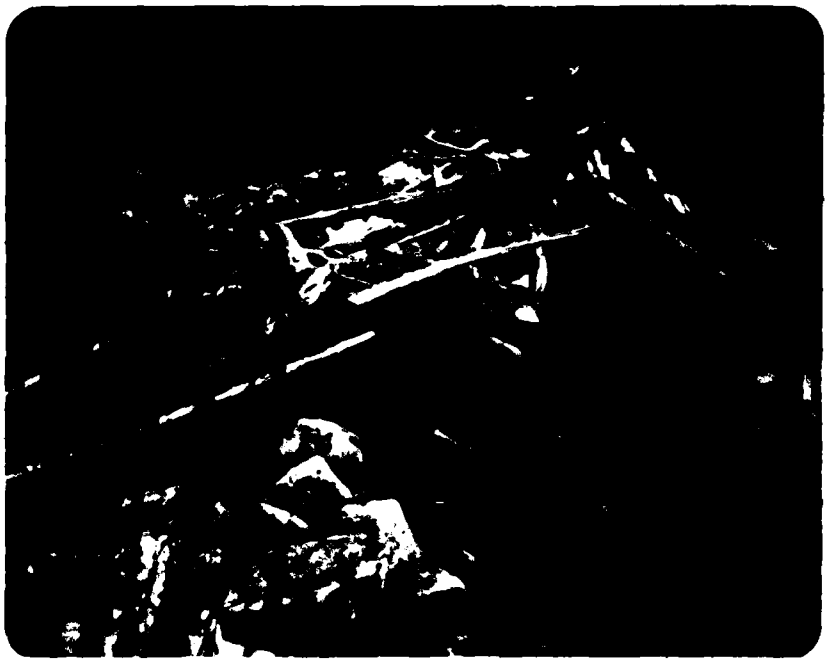
13. Trashrack for Outlet

14. Gate Mechanism



15. Left Wall of Auxiliary Spillway

16. Downstream channel



17. Emergency Spillway Sill

18. Riprap on Emergency Spillway Channel

19. Downstream abandoned dam, looking downstream

20. Downstream abandoned dam, looking to right

APPENDIX D

HYDROLOGIC AND HYDRAULIC CALCULATIONS

Job No. 9111 0 Sheet 1 of 46
Project DAM INSPECTION WORK Date 11/20/79
Subject RESERVOIR DATA By FMC Ch'k. by

EAST LONG POND DAM

NORMAL POOL SURFACE AREA (ELEVATION 1208 ft) USGS

READING 1	READING 2	READING 3
0.30	$0.58/_2 = 0.29$	$0.87/_3 = 0.29$

AVERAGE = $0.87/_3 = 0.29$

AREA = $0.973 (0.29) = 0.28 \text{ mi}^2 = 180.6$ acres

MAXIMUM POOL AREA TO BE OBTAINED VIA GRAPH ON PAGE 2, UTILIZING POOL AREA AT NEXT CONTOUR LEVEL (ELEV. 1220 ft)

READING 1	READING 2	READING 3
0.35	$0.72/_2 = 0.36$	$1.08/_3 = 0.36$

AVERAGE = $1.08/_3 = 0.36$

AREA = $0.36 \times 0.973 = 0.35 \text{ mi}^2 = 224.2$ acres

NORMAL POOL STORAGE (1208') (assume vertical walls)

HEIGHT TO SPILLWAY = 18'

$18' \times 180.6$ acres = 3250.8 acre-ft $\approx$ 3251 a-f

SURCHARGE STORAGE (1210')

$2' \times \left(\frac{180.6 + 187.5}{2}\right) = 368.2$ a-f

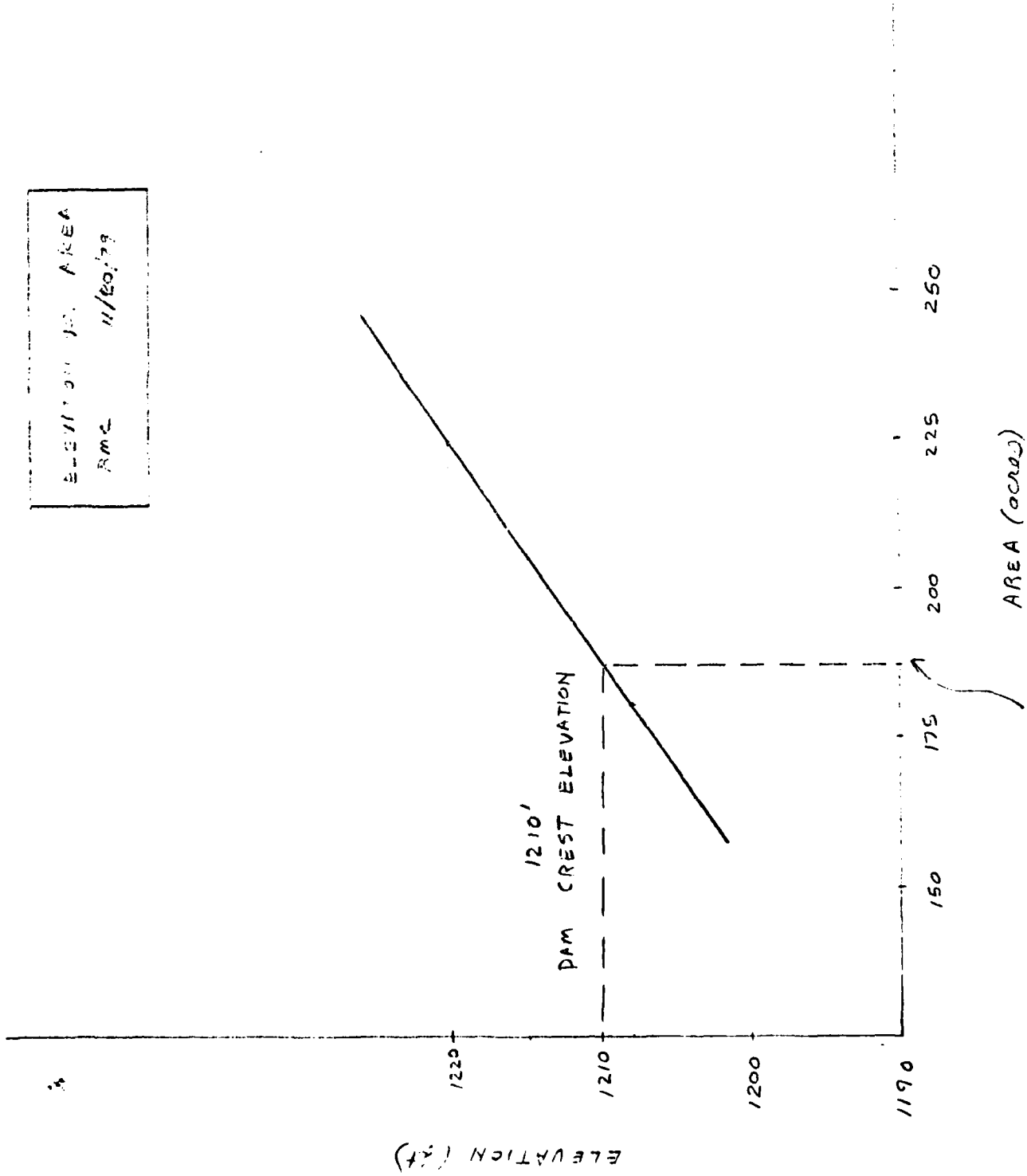
MAXIMUM POOL STORAGE

SUM OF SURCHARGE AND NORMAL STORAGE

$368.2 + 3250.8 = 3619.0$ a-f

Job No. 9110 Sheet 2 of 46
Project DAM INSPECTION Date 11/20/79
Subject RESERVOIR STORAGE By KMC Ch'k. by

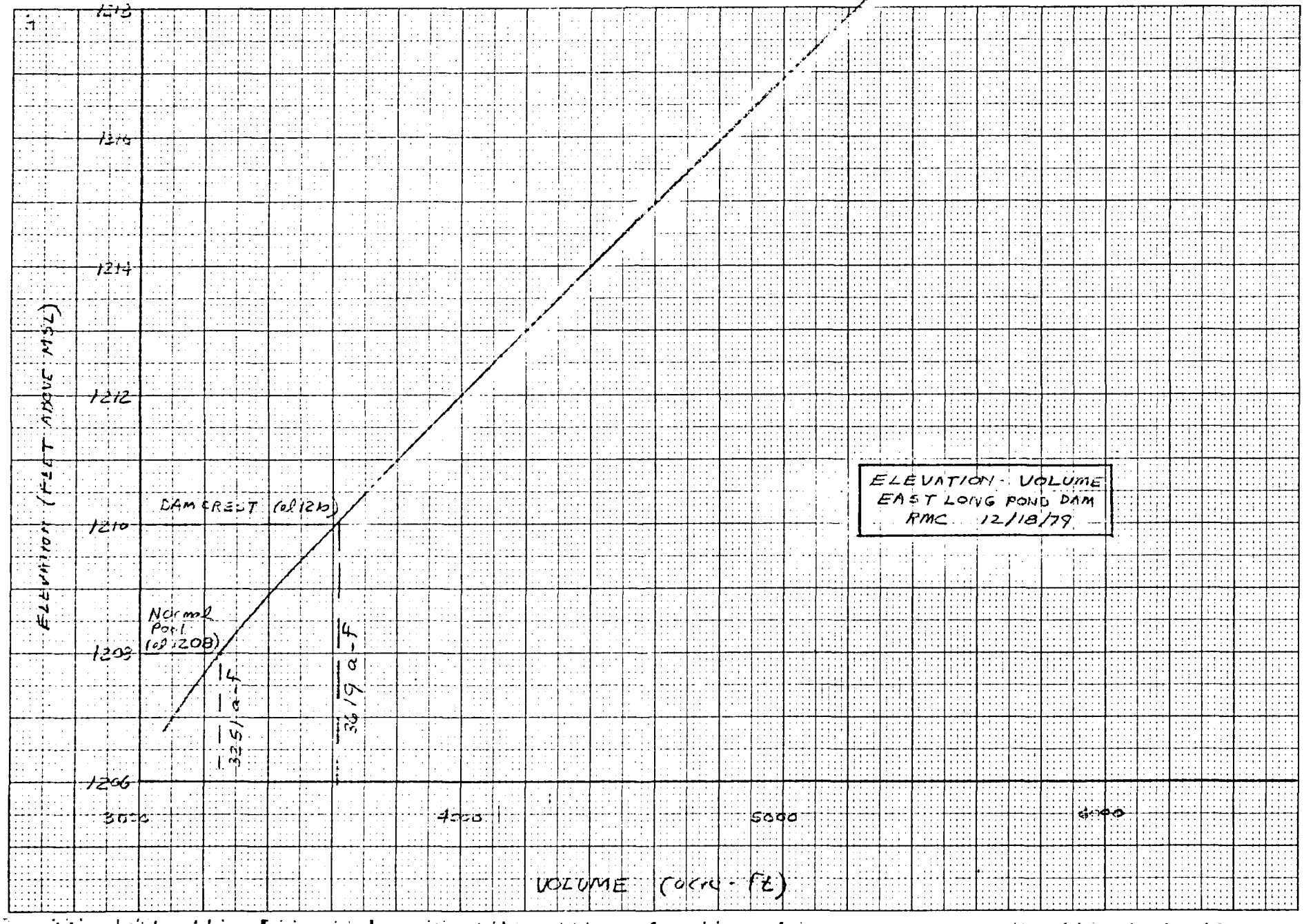
ELEVATION - AREA
RMC 11/20/79



Job No. 9110 Sheet 3 of 46
Project East Long Pond Dam Date 12/18/79
Subject ELEVATION - VOLUME COMPUTATIONS By RMC Ch'k. by

ELEVATION (ft)	AREA (acres)	$\frac{A_1+A_2}{2}$ (acres)	HEIGHT (ft)	INCREMENTAL VOLUME (a-F)	TOTAL VOLUME (a-F)
1208	180.6				3250.8
		184.1	2		
1210	187.5			368.2	3619.0
		196.25	5		
1215	205.0			981.3	4600.3
		214.6	5		
1220	224.2			1073	5673.3

K·E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



Job No. 9110 Sheet 5 of 46
Project EAST LONG POND DAM Date 11/20/79
Subject HYDRAULICS / HYDROLOGY By RMC Ch'k. by

EAST LONG POND DAM - Located in Woodbury, VT

CLASSIFICATION : SIZE - INTERMEDIATE (Based on Storage)

HAZARD - HIGH (based upon Location of Numerous down stream homes)

BASIC DATA :

DRAINAGE AREA = 3.94 mi^2

RESERVOIR : NORMAL POOL ELEVATION 1208 FEET (USGS)
STORAGE 3251.0 ACRE-FEET

MAXIMUM POOL ELEVATION 1210 FEET
STORAGE 3619.0 ACRE-FEET

SURFACE AREA
180.6 ACRES (NORMAL POOL)
197.5 ACRES (MAXIMUM POOL)

DAM : EARTH with vertical stone facing on parts of down-stream face
MAXIMUM HEIGHT 20 FEET
LENGTH 260 FEET

SPILLWAY : AUXILLIARY - 12 FOOT WEIR
ELEVATION 1208.8 FEET

EMERGENCY - 80' FOOT WEIR
ELEVATION 1208.0 FEET

OUTLET : 36" ϕ CONCRETE PIPE
INVERT ELEV 1191.8 ± PER STATE OF VERMONT SURVEY

Job No. 71110 Sheet 6 of 46
Project EAST LONG POND DAM Date 11-0/77
Subject HYDRAULICS / HYDROLOGY By RM Ch'k. by GJ

STEP 1

CALCULATION OF TEST FLOOD

CLASSIFICATION SIZE - INTERMEDIATE

HAZARD - HIGH

DAM SAFTEY GUIDELINES RECOMMEND

PMF

PMF FOUND ON PMF CURVE ENVELOPE

BASIN - MOUNTAINOUS

$PMF = 2350 cfs/mi^2$

$PMF = 2350 \frac{cfs}{mi^2} \times 3.44 mi^2 = 8084 cfs \simeq 8100 cfs$

$PMF = 8100 cfs$

$\frac{1}{2} PMF = 4050 cfs$

STEP 2

CALCULATION OF SURCHARGE BY FULL PMF

AUXILLIARY SPILLWAY - CREST ELEVATION 1208.8'

$Q = C_w L H^{3/2}$

$Q_{MS} = 2.9 (12) H^{3/2}$

$Q_{MS} = 34.8 H^{3/2}$

$L = 12$

$C_w = 2.9$ (conservative value chosen due to field debris could obstruct weir)

Job No. 9110 Sheet 7 of 46
Project EAST LONG POND DAM Date 11/20/79
Subject HYDRAULICS / HYDROLOGY By PMC Ch'k. by

EMERGENCY SPILLWAY - CREST ELEVATION 1208'

$Q_{ES} = C_w L H^{3/2}$

$L = 80'$

$C_w = 3.1$ (conservative value chosen due to field conditions)

$Q_{ES} = 3.1(80) H^{3/2}$

$Q_{ES} = 248 H^{3/2}$

DAM CREST - ELEVATION 1210'

Left Embankment near auxilliary spillway

$Q = C_w L H^{3/2}$

$L = 95'$

$C_w = 2.6$ (conservative value chosen due to field conditions)

$Q = 2.6(95) H^{3/2}$

$Q = 247 H^{3/2}$

DAM CREST - ELEVATION 1211.3'

Left Embankment near left abutment

$Q = C_w L H^{3/2}$

$L = 80'$

$C_w = 2.6$ (conservative value chosen due to field conditions)

$Q = 2.6(80) H^{3/2}$

$Q = 208 H^{3/2}$

Job No. 91110 Sheet 8 of 46
Project East Long Pond Dam Date 1/29/80
Subject Hydraulics By RMC Ch'k. by CB

DAM CREST - ELEVATION 1211.5'

RIGHT EMBANKMENT

Majority of 85 foot right embankment is a hill which will not be overtopped (≈ 5' above left embankment) But small length of embankment before and after hill will conduct flow - Length ≈ 20' - elevation 1211.5 (to left and right)

$$Q = C L H^{3/2}$$

$$Q = 2.6(20)(H^{3/2})$$

$$Q = 52 H^{3/2}$$

$C = 2.6$ (conservative)

$L = 20'$

36" ϕ OUTLET PIPE - ASSUMED NON-EFFECTIVE IN FLOW COMPUTATIONS BECAUSE IT HAS A GATED OPENING. OPENING MECHANISM HAS BEEN REMOVED, AND IF REINSTALLED WOULD BE IN MIDDLE OF SPILLWAY, MAKING USE DURING FLOOD IMPROBABLE

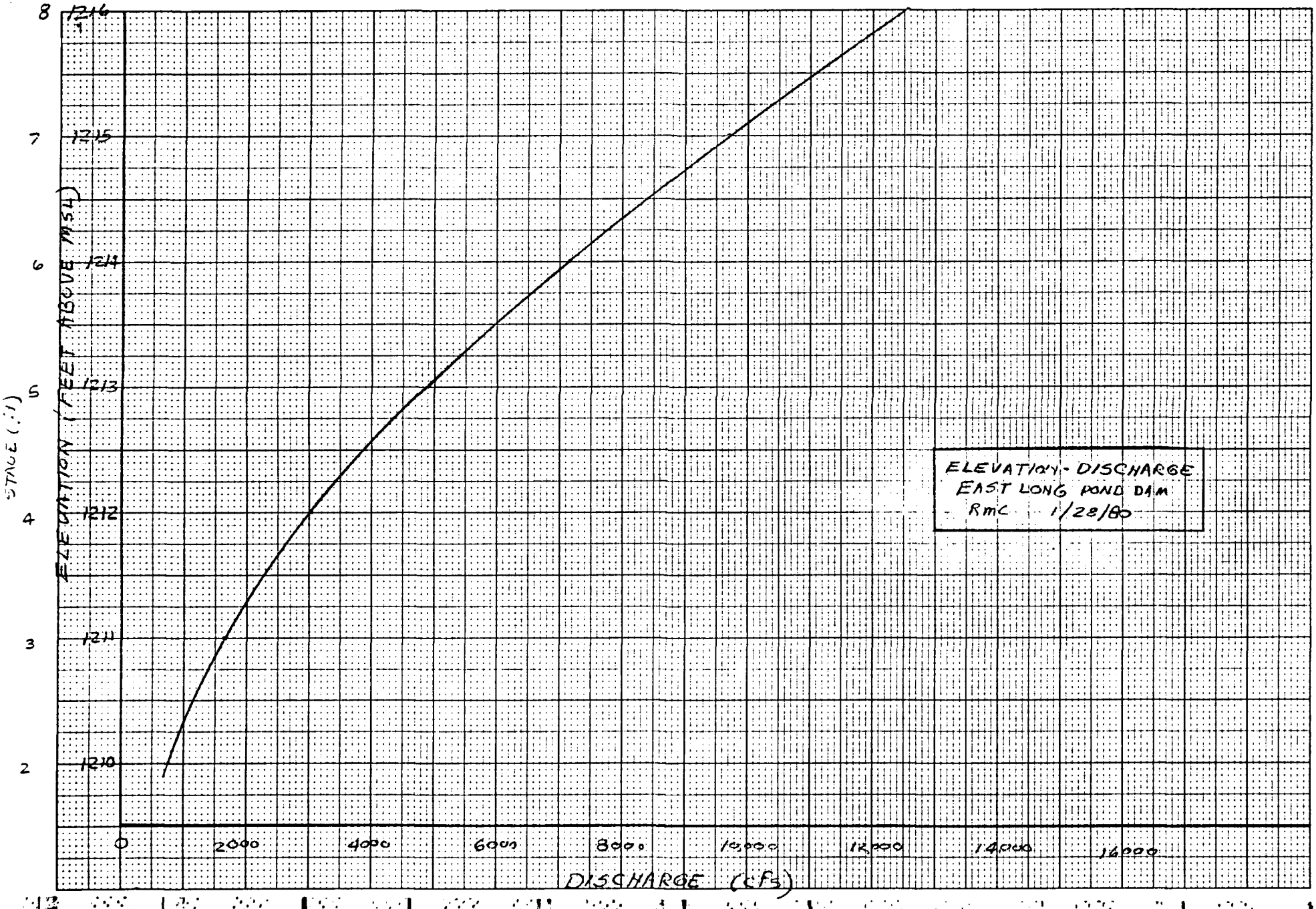
(el 1208.8) (el 1208.0)

WATER ELEVATION	AUXILLARY SPILLWAY (12')		EMERGENCY SPILLWAY (80')		DAM CREST (el 1210.0)		(el 1211.3)		(el 1211.5)		TOTAL
	Head	Flow	Head	Flow	Head	Flow	Head	Flow	Head	Flow	Flow
(ft)	(ft)	(cfs)	(ft)	(cfs)	(ft)	(cfs)	(ft)	(cfs)	(ft)	cfs	(cfs)
1208	0	–	–	–	–	–	–	–	–	–	0
		[3.43 H^2.5]		[2.48 H^2.5]		[2.47 H^2.5]		[2.03 H^2.5]		[5.52 H^2.5]	
1209	0.2	3	1.0	248	0	–	0	–	0	–	251
1210	1.2	46	2.0	701	0	–	0	–	0	–	747
1211	2.2	114	3.0	1289	1.0	247	0	–	0	–	1650
1212	3.2	199	4.0	1984	2.0	699	0.7	122	0.5	18	3022
1213	4.2	300	5.0	2773	3.0	1283	1.7	461	1.5	96	4913
1214	5.2	413	6.0	3645	4.0	1976	2.7	923	2.5	206	7163
1215	6.2	537	7.0	4593	5.0	2762	3.7	1480	3.5	341	9713
1216	7.2	672	8.0	5612	6.0	3630	4.7	2119	4.5	496	12529

Job No. 9110
Project East Long Pond Dam
Subject Hydraulics / Hydrology
Sheet 9 of 46
Date 1/28/80
By RMC Chk. by

DuBois & King, Inc. ENGINEERING AND ENVIRONMENTAL SERVICES RANDOLPH VERMONT 05060

K·E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



Job No. 91110 Sheet 11 of 46
Project East Long Pond Dam Date 1/28/80
Subject Hydraulics / Hydrology By RMC Ch'k. by

STEP 3 EFFECT OF SURCHARGE STORAGE ON PMF

Q_{P_1} = 8100 cfs Height of surcharge$_1$ = 6.4' (el 1214A) (see rating curve)

$STOR_1$ = SURCHARGE VOLUME = TOTAL VOLUME − NORMAL POOL VOLUME (from elevation volume curve)

$STOR_1$ = 4480 − 3251 = 1229 a-f

$$STOR_1 = \frac{1229 \text{ a-f} \times 12 \text{ "/ft}}{3.44 \text{ mi}^2 \times 640 \text{ ac/mi}^2} = 6.6988"$$

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR_1}{19"}\right) = 8100\left(1 - \frac{6.6988}{19}\right) = 5244 \text{ cfs}$$

SURCHARGE HEIGHT$_2$ = 5.18' (el 1213.18')

$STOR_2$ = 4260 − 3251 = 1009 a-f

$$STOR_2 = \frac{1009 \times 12}{3.44 \times 640} = 5.4996"$$

$STOR_{AVE} = (5.4996 + 6.6988)/2 = 6.0992"$

$$Q_{P_3} = 8100\left(1 - \frac{6.0992}{19}\right) = 5500 \text{ cfs}$$

SURCHARGE HEIGHT$_3$ = 5.3' (el 1213.3)

$STOR_3$ = 4280 − 3251 = 1029 a-f

$$STOR_3 = \frac{1027 \times 12}{3.44 \times 640} = 5.6086"$$

$STOR_{AVE} = (5.6086 + 6.0992)/2 = 5.8539"$

$$Q_{P_4} = 8100\left(1 - \frac{5.8539}{19}\right) = 5604 \text{ cfs}$$

SURCHARGE HEIGHT$_4$ = 5.33' (el 1213.33)

$STOR_4$ = 4290 − 3251 = 1039 a-f

$$STOR_4 = \frac{1039 \times 12}{3.44 \times 640} = 5.6632 \text{ cfs}$$

$STOR_{AVE} = (5.6632 + 5.8539)/2 = 5.7586"$

$$Q_{P_5} = 8100\left(1 - \frac{5.7586}{19}\right) = 5645 \text{ cfs}$$

SURCHARGE HEIGHT$_5$ = 5.34' (el 1213.34)

Job No. 91110 Sheet 12 of 46
Project East Long Pond Date 4/10/80
Subject Hydraulics By RMC Ch'k. by

surcharge height$_5$ = surcharge height$_4$ = 5.34 ≈ 5.3' (el 1212.3') values will not change, no further iterations necessary

Since dam is overtopped, ½ PMF must be routed to determine spillway adequacy

Q_{P_1} = 4050 cfs surcharge height$_1$ = 4.6' (el 1212.6')

$STOR_1$ = 4120 - 3251 = 869 a-f

$$STOR_1 = \frac{869 \text{ a-f} \times 12''/\text{ft}}{3.44 \text{ mi}^2 \times 640 \text{ acres/mi}^2} = 4.7366''$$

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR_1}{9.5''}\right) = 4050\left(1 - \frac{4.7366}{9.5}\right) = 2031 \text{ cfs}$$

surcharge height$_2$ = 3.3' (1211.3')

$STOR_2$ = 3860 - 3251 = 609 a-f

$$STOR_2 = \frac{609 \times 12}{3.44 \times 640} = 3.3174''$$

$$STOR_{avg} = (3.3194 + 4.7366)/2 = 4.0280$$

$$Q_{P_3} = 4050\left(1 - \frac{4.0280}{9.5}\right) = 2333 \text{ cfs}$$

surcharge height$_3$ = 3.5' (el 1211.5')

$STOR_3$ = 3900 - 3251 = 649 a-f

$$STOR_3 = \frac{649 \times 12}{3.44 \times 640} = 3.5374''$$

$$\text{Storage} = (3.5374 + 4.0280)/2 = 3.7827''$$

$$Q_{P_4} = 4050\left(1 - \frac{3.7827}{9.5}\right) = 2437 \text{ cfs}$$

surcharge height$_4$ = 3.65' (1211.65')

Job No. 91110 Sheet 13 of 46
Project East Long Pond Date 4/10/80
Subject Hydraulics By RMC Ch'k. by

$STOR_4 = 3930 - 3251 = 679$ a-f

$$STOR_4 = \frac{679 \times 12}{3.44 \times 640} = 3.7009"$$

$$STOR_{ave} = (3.7009 + 3.7827)/2 = 3.7418"$$

$$Qp_5 = 4050\left(1 - \frac{3.7418}{9.5}\right) = 2455 \text{ cfs}$$

surcharge height$_6$ = 3.65' (el 1211.65)

surcharge height$_6$ = surcharge height$_5$ = 3.65' ≈ 3.7' (el 1211.7')
values will not change, no further iterations necessary

CONCLUSIONS

1) Reservoir storage will reduce the Full PMF test inflow to an outflow of 5645 cfs (30% reduction) The ½ PMF test inflow will be reduced, due to reservoir storage, to 2455 cfs (39% reduction)

2) the spillways can only pass 747 cfs before the dam is overtopped (13% of test outflow of 5645 cfs; 30% of test outflow of 2455 cfs)

3) The PMF will cause a dam overtopping of 3.3' (el. 1213.3'). ½ PMF causes the dam to be overtopped by 1.7' (el 1211.7')

Job No. 7110 Sheet 13A of 46
Project East Long Pond Dam Date 4/29/80
Subject DAM BREACH ANALYSIS By RMC Ch'k. by

DOWNSTREAM DAMAGE ESTIMATE

Corps of Engineers recommends this procedure - Do breach analysis w/water to top of dam (Full spillway capacity being used) Check to see if one or more homes will be affected. If so, use this case. If not, try analysis w/ water to crest of spillway (negligible downstream discharge). Using this order of analysis, a case will be found which possibly could cause damage and/or loss of life, which is the object of the analysis.

case 1. water at top of dam (el 1210.0)

$$Q_{P_1} = \frac{8}{27} W_b \sqrt{g}\, Y_o^{3/2} = \frac{8}{27}(70\text{ ft})(\sqrt{32})(20)^{3/2} = 10494 \text{ cfs}$$

$$Q_{P_1} = 10,500 \text{ cfs}$$

W_b = breach width (dam width = 260 feet, Maximum anticipated dam failure width = 70 feet (based on rock knoll)
Y_o = height of water upstream of dam

initial downstream discharge = 747 cfs, stage of 2.0'

total flow after breach = 10,500 + 747 = 11,247 cfs, stage = 8.8'

FLOOD WAVE = Δ stage = 8.8 - 2.0 = 6.8'

A 6.8' flood wave would cause concidernable downstream damage (at Mackville Pond Village (homes ≈ 3.4' above dam crest), and at Village of Haidwick)

STEP 1 - Reservoir storage

@ el 1210.0 = 3619 a-f

STEP 2 Peak Failure Outflow

Q_{P_1} = (from above calculations) = 10,500 cfs

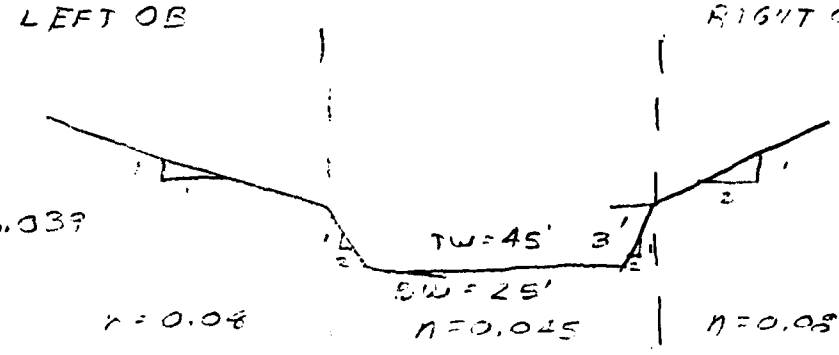
STEP 3 Develop downstream stage - discharge curves

Manning's Equation used

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$$R = A/P$$

DOWNSTREAM XS Approximated from survey data, by JAS, JJB



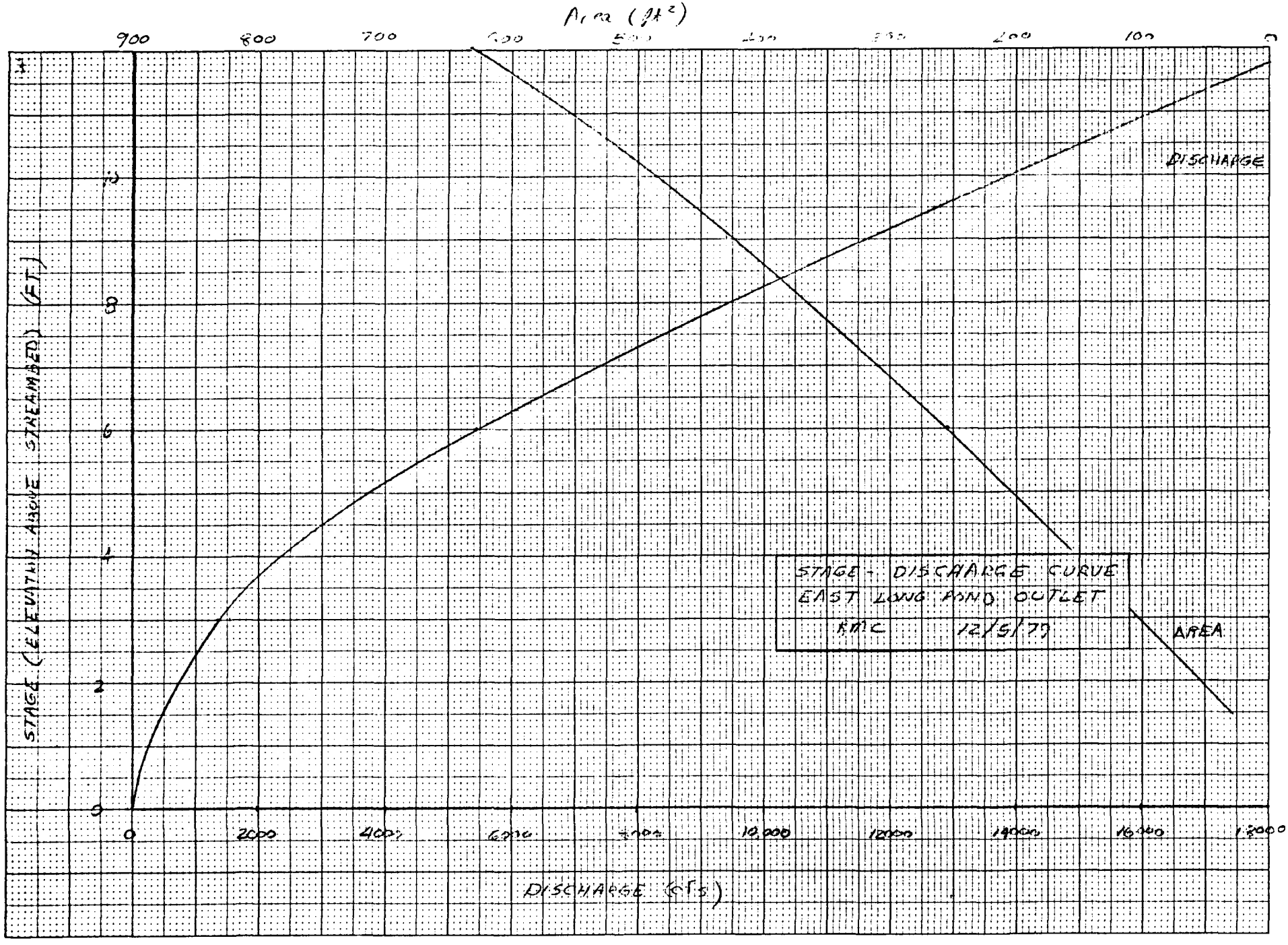
	CHANNEL			RIGHT OVERBANK			LEFT OVERBANK			TOTAL	TOTAL
STAGE	AREA	WETTED PERIMETER	FLOW	AREA	WETTED PERIMETER	FLOW	AREA	WETTED PERIMETER	FLOW	AREA	FLOW
(ft)	(ft^2)	(ft)	(cfs)	(ft^2)	(ft)	(cfs)	(ft^2)	(ft)	(cfs)	(ft^2)	(cfs)
3	105	37	1367	-	-	-	-	-	-	105	1367
6	240	37	5391	9	6.7	40	4.5	4.27	17	253.5	5448
9	375	37	11308	36	13.4	254	18	8.5	109	429	11671
12	510	37	18839	81	20.1	747	40.5	12.7	320	631.5	19906
15	645	37	27,820	144	26.8	1607	72	17.0	687	861	30,114

STEP 3 - STAGE DISCHARGE RATING CURVE

Job No. 91110
Project East Long Pond Dam
Subject Hydraulics / Hydrology
Sheet 14 of 46
Date 1/28/80
By RMC Chk. by

DuBois & King, Inc. ENGINEERING AND ENVIRONMENTAL SERVICES RANDOLPH VERMONT 05060

K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



Job No. 91118 Sheet 16 of 46
Project NICHOLS POND DAM Date 11/27/79
Subject HYDRAULICS / HYDROLOGY By RMC Ch'k. by

STEP 2 CALCULATION OF SURCHARGE BY PMF

DAM CREST ELEVATION 1130.5'

$Q = C_w L H^{3/2}$

$Q = 200 (2.63) H^{3/2}$

$Q = 526 H^{3/2}$

$L = 200'$

$C_w = 2.63$ from King and Breter Page 5-46, Table 5-

BROAD CRESTED WEIR

Job No. 91118 Sheet 17 of 46
Project NICHOLS POND DAM Date 11/26/79
Subject HYDRAULICS / HYDROLOGY By RMC Ch'k. by

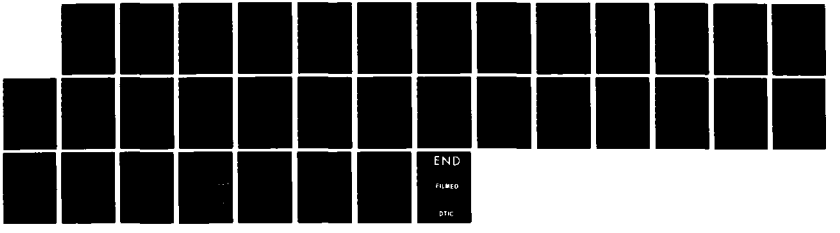
OUTLET ASSUMED NON EFFECTIVE IN FLOW COMPUTATIONS BECAUSE OUTLET IS GATED. GATE OPENING MECHANISM HAS BEEN REMOVED. ALSO, THE OPERATOR WOULD HAVE TO STAND IN THE MIDDLE OF THE SPILLWAY TO OPERATE THE GATES, MAKING ITS USE UNLIKELY DURING A FLOOD.

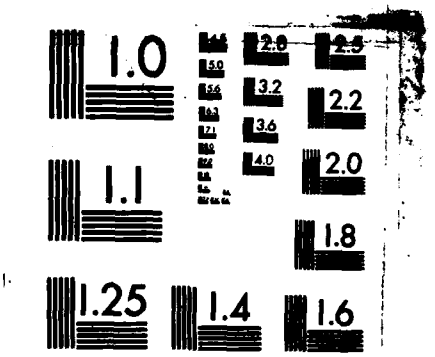
SPILLWAY

IRREGULAR SPILLWAY REQUIRES SPECIAL COMPUTATIONS TO DETERMINE IF INLET OR OUTLET CONTROLS FLOW. A RATING CURVE FOR THE SPILLWAY (shown of Page 6 of 16) INDICATES A CAPACITY OF 215cfs AT DAM CREST (ELEVATION 1130.5') CONSEQUENTLY WHEN THE ENTIRE DAM IS OVERTOPPED (ELEV. 1130.5'), THE SPILLWAY WILL BECOME INSIGNIFICANT IN FLOW CALCULATIONS, THE WEIR-LIKE FLOW OVER THE DAM CREST WILL DOMINATE.

AD-A157 217 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
EAST LONG POND DAM (Y.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV APR 80

UNCLASSIFIED F/G 13/13 NL



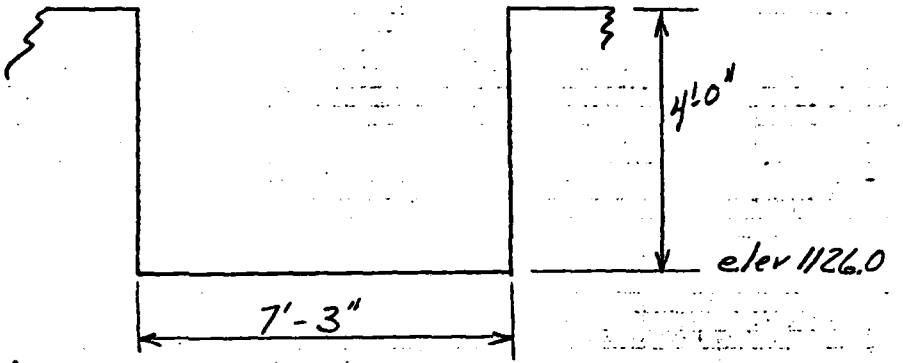


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Job No. 91118 Sheet 18 of 46
Project Nichols Pond Dam Date 11-28-79
Subject Spillway Rating Curve By JR Ch'k. by

1. Rating curve for downstream end

a. Sketch:



b. find discharge for various depths at Critical Depth
Ref King & Brater p 8-8 (formulae 8-29)

$$Q = \sqrt{g}\, b\, D_c^{3/2}, \quad (\sqrt{g} = 5.17;\ b = 7.25)$$

$$Q = 41.1\, D_c^{3/2}$$

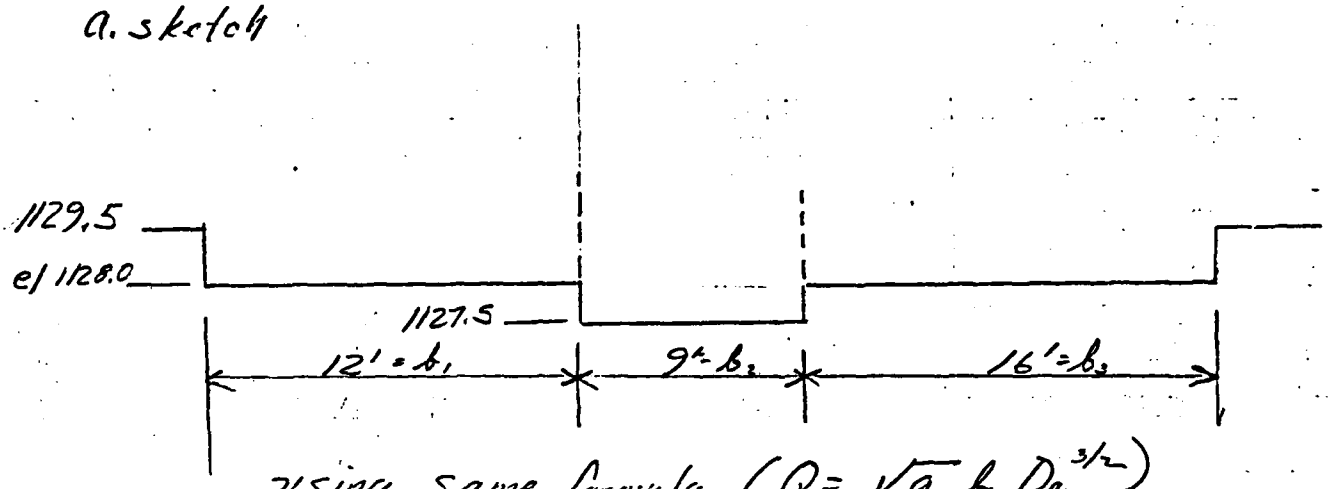
$EGL = Z_o + d_c + H_{va}$, where $Z_o = 1126.0$; $H_v = \frac{D_c}{2}$

depth	$D_c^{3/2}$	Q	H_v	EGL	
0.5	0.35	15	0.25	1126.8	
1.0	1.0	41	0.5	1127.5	
2.0	2.83	116	1.0	1129.0	
3.0	5.2	214	1.5	1130.5	
4.0	8.0	329	2.0	1132.0	
6.0	14.7	603	3.0	1135.0	
8.0	22.6	928	4.0	1138.0	

Job No. 9116 Sheet 19 of 46
Project Nichols Pond Dam Date 11-28-74
Subject Spillway Rating Curves By GB Ch'k. by

2. Rating curve for upstream end of spillway

a. sketch



Using same formula ($Q = \sqrt{g}\, b\, D_c^{3/2}$)
we will combine b_1 and b_3 and investigate

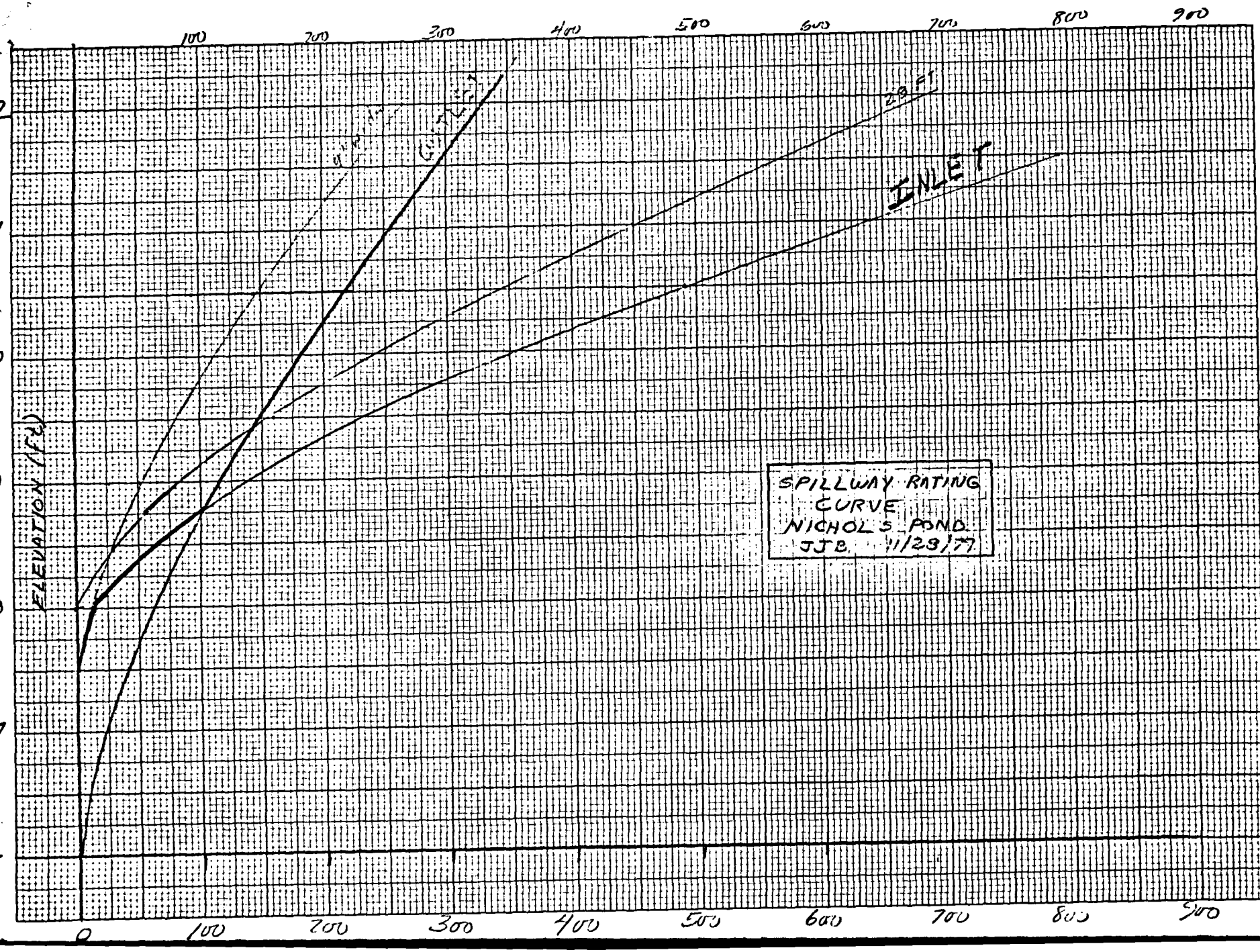
$b_4 = b_1 + b_3 = 28'$

b. determine two rating curves and combine

$b_4 = 28$, $Q = 158.8\, D_c^{3/2}$

$z_0 = 1128.0$ d	$D_c^{3/2}$	Q	Hv	EGL
0.5	.35	56	0.25	1128.8
1.0	1.0	159	0.5	1129.5
1.5	1.84	292	0.75	1130.3
2.0	2.83	449	1.0	1131.0
2.5	3.95	628	1.25	1131.8
$z_0 = 1127.5$		$b_2 = 9$, $Q = 51.0\, D_c^{3/2}$		
0.5	.35	18	0.25	1128.3
1.0	1.0	51	0.5	1129.0
1.5	1.84	94	0.75	1129.8
2.0	2.83	144	1.0	1130.5
2.5	3.95	202	1.25	1131.3
3.0	5.2	265	1.5	1132.0

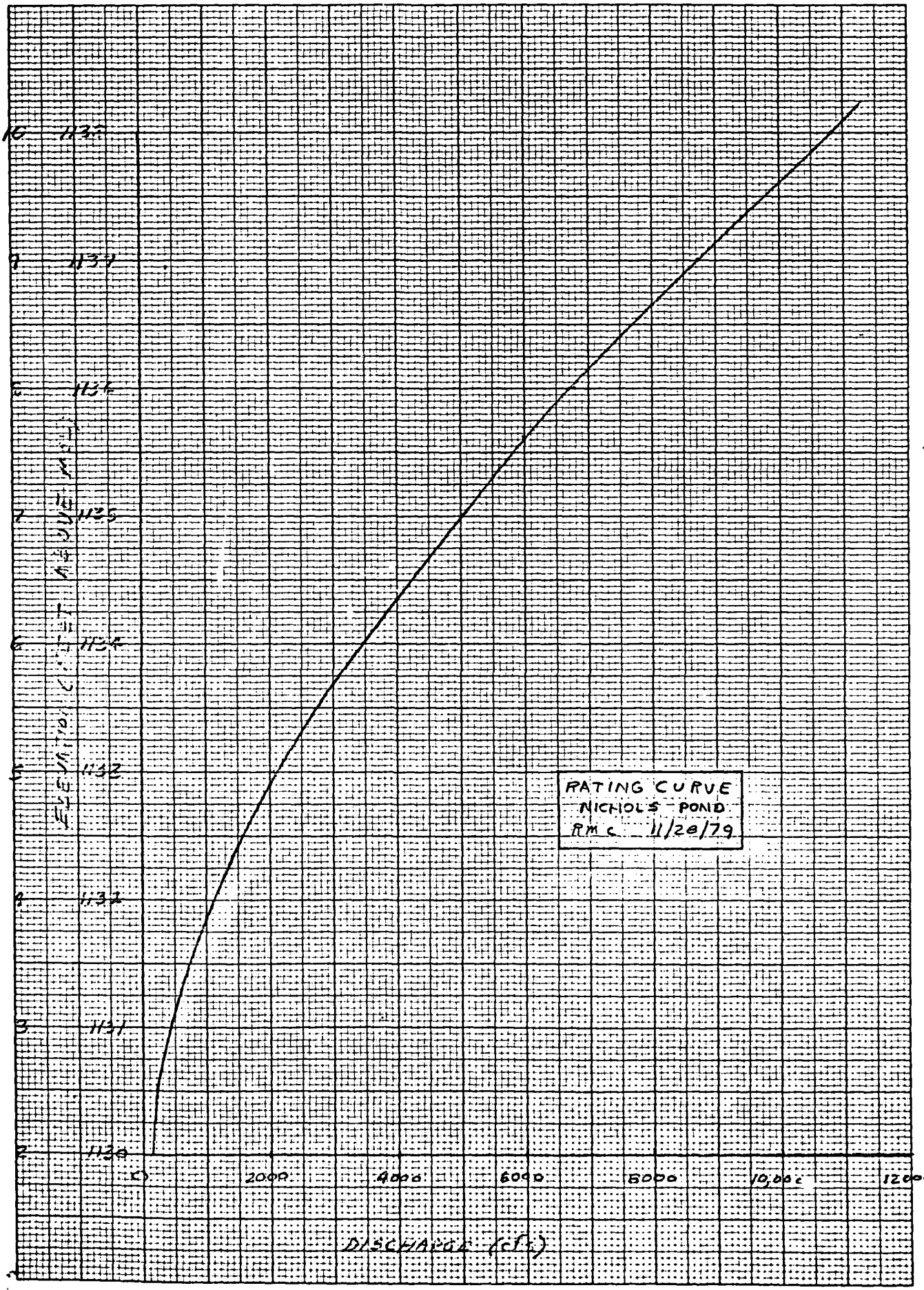
K•Σ 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



Job No. 91118 Sheet 21 of 46
Project NICHOLS POND DAM Date 11/28/79
Subject HYDRAULICS / HYDROLOGY By RMC Ch'k. by

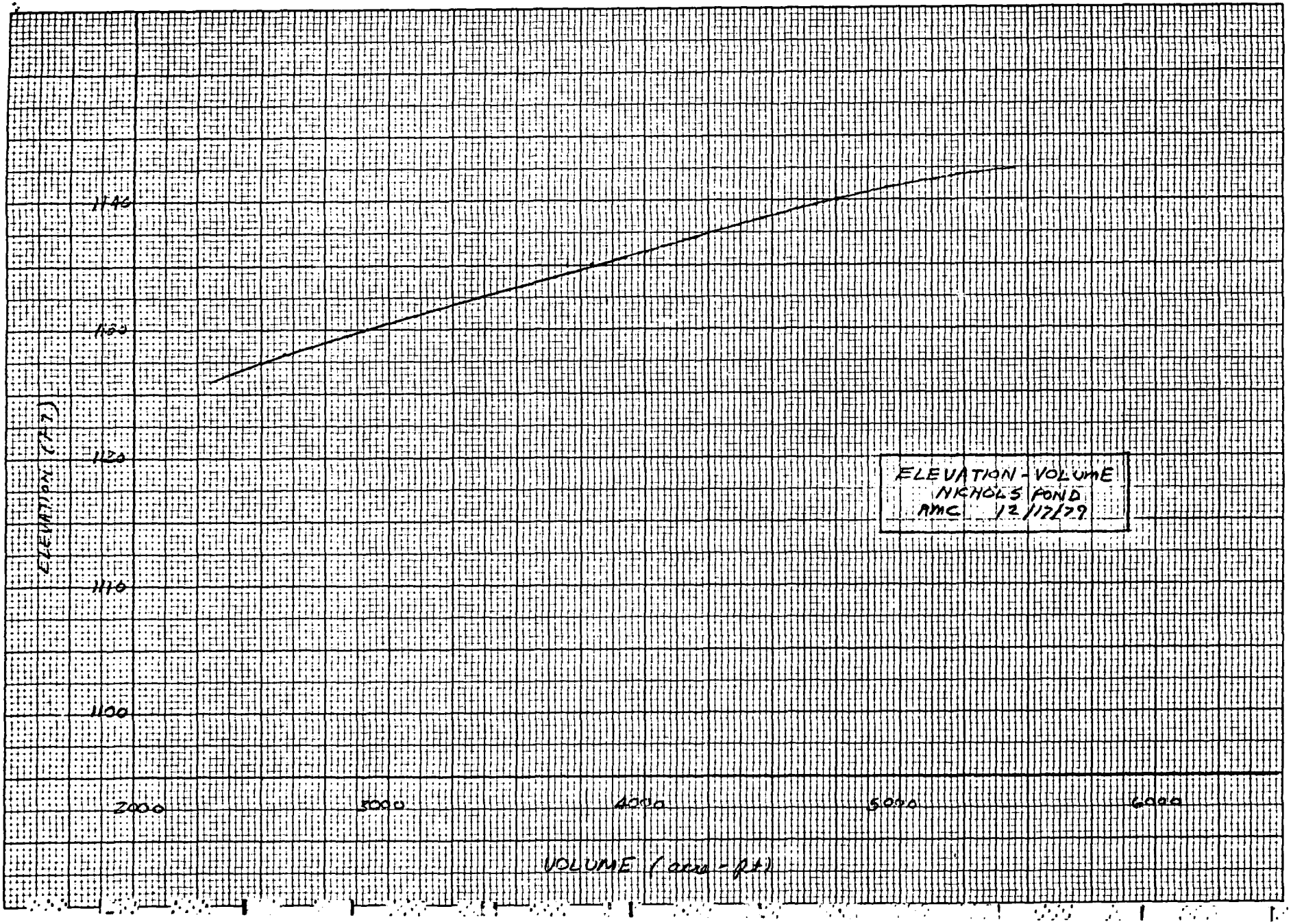
WATER SURFACE ELEVATION	PRIMARY SPILLWAY HEAD (ft)	PRIMARY SPILLWAY FLOW (cfs)	DAM CREST (el 1130.5) HEAD (ft)	DAM CREST (el 1130.5) FLOW (cfs)	TOTAL FLOW (cfs)
1127	0	-	0	-	0
1127.5	0	-	0	-	0
1128	0.5	13	0	0	13
1129	1.5	115	0	0	115
1130	2.5	183	0	0	183
1131	3.5	256	0.5	186	442
1132	4.5	330	1.5	966	1296
1133 *	-	-	2.5	2079	2079
1134 *	-	-	3.5	3444	3444
1130.5	3.0	218	0	0	218
1135 *	-	-	4.5	5021	5021
1136 *	-	-	5.5	6785	6785
1137 *	-	-	6.5	8717	8717
1138 *	-	-	7.5	10804	10804
1139 *	-	-	8.5	13035	13035

* Discharge over spillway not included above el. 1132 because configuration of dam is assumed to control



46 1320
K&E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

K&E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



NICHOLS POND OUTLET

MANNINGS EQUATION USED

$$Q = \frac{1.486}{n}(A)\,R^{2/3}\,S^{1/2} \qquad R = A/P$$

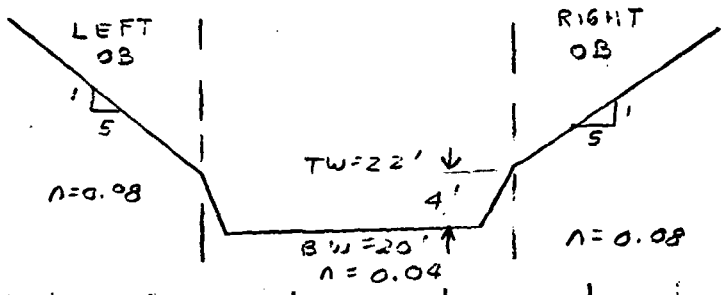
$L = 10,500$

$\Delta elev = 1128 - 933$

$\Delta elev = 95'$

$S = 95/10500$

$S = 0.019$



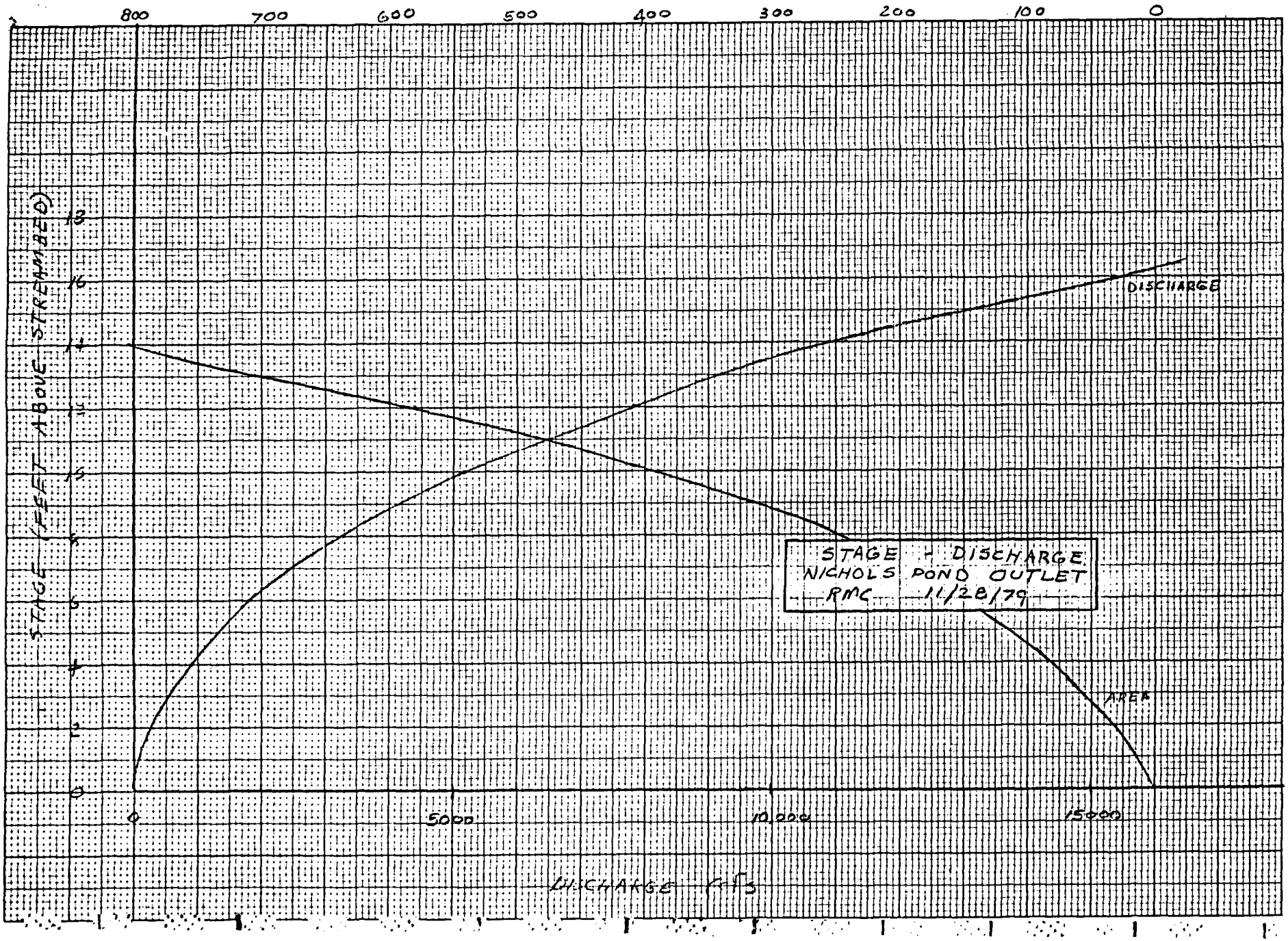
XS APPROXIMATED FROM JJB SURVEY

	CHANNEL			RIGHT OVERBANK			LEFT OVERBANK				
STAGE	AREA	WETTED PERIMETER	FLOW	AREA	WETTED PERIMETER	FLOW	AREA	WETTED PERIMETER	FLOW	TOTAL AREA	TOTAL FLOW
(ft)	(ft^2)	(ft)	(cfs)	(ft^2)	(ft)	(cfs)	(ft^2)	(ft)	(cfs)	(ft^2)	(cfs)
4	84	28.25	935	–	–	–	–	–	–	84	885
6	128	28.25	1702	10	10.2	25	10	10.2	25	148	1824
8	172	28.25	2909	40	20.4	160	40	20.4	160	252	3229
10	216	28.25	4246	90	30.6	471	90	30.6	471	396	5188
12	260	28.25	5777	160	40.8	1012	160	40.8	1012	580	7801
14	304	28.25	7489	250	51	1833	250	51	1833	804	11155
16	348	28.25	9372	360	61	2983	360	61	2983	1068	15338

DuBois & King, Inc. ENGINEERING AND ENVIRONMENTAL SERVICES RANDOLPH VERMONT 05060

K·E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 1320



Job No. 9116 Sheet 26 of 46
Project MACKVILLE POND DAM Date 12/5/79
Subject HYDRAULICS / HYDROLOGY By RMC Ch'k. by

STEP 2 CALCULATION OF SURCHARGE BY PMF

SPILLWAY ELEVATION 925.0'

$Q = C_w L H^{3/2}$

$Q = 3.1(39) H^{3/2}$

$Q = 120.9 H^{3/2}$

$L = 23 + 16 = 39'$

$C_w = 3.1$ (based upon field conditions)

DAM CREST ELEVATION 927.0'

$Q = C_w L H^{3/2}$

$Q = 3.0(41.5) H^{3/2}$

$Q = 124.5 H^{3/2}$

$L = 80.5 - 39 = 41.5'$

$C_w = 3.0$ (based upon field conditions)

DIKE ELEVATION 929.3'

THE ROADWAY TO THE LEFT OF THE DAM HAS HAD FLOOD WATERS USE IT AS AN EMERGENCY SPILLWAY. IT WILL BE CONCIDERED AS A WEIR WITH A LENGTH OF 75', VERTICAL WALLS ARE ASSUMED TO STAY CONSERVATIVE.

$Q = C_w L H^{3/2}$

$Q = 2.6(75)(H^{3/2})$

$Q = 195 H^{3/2}$

$L = 75'$

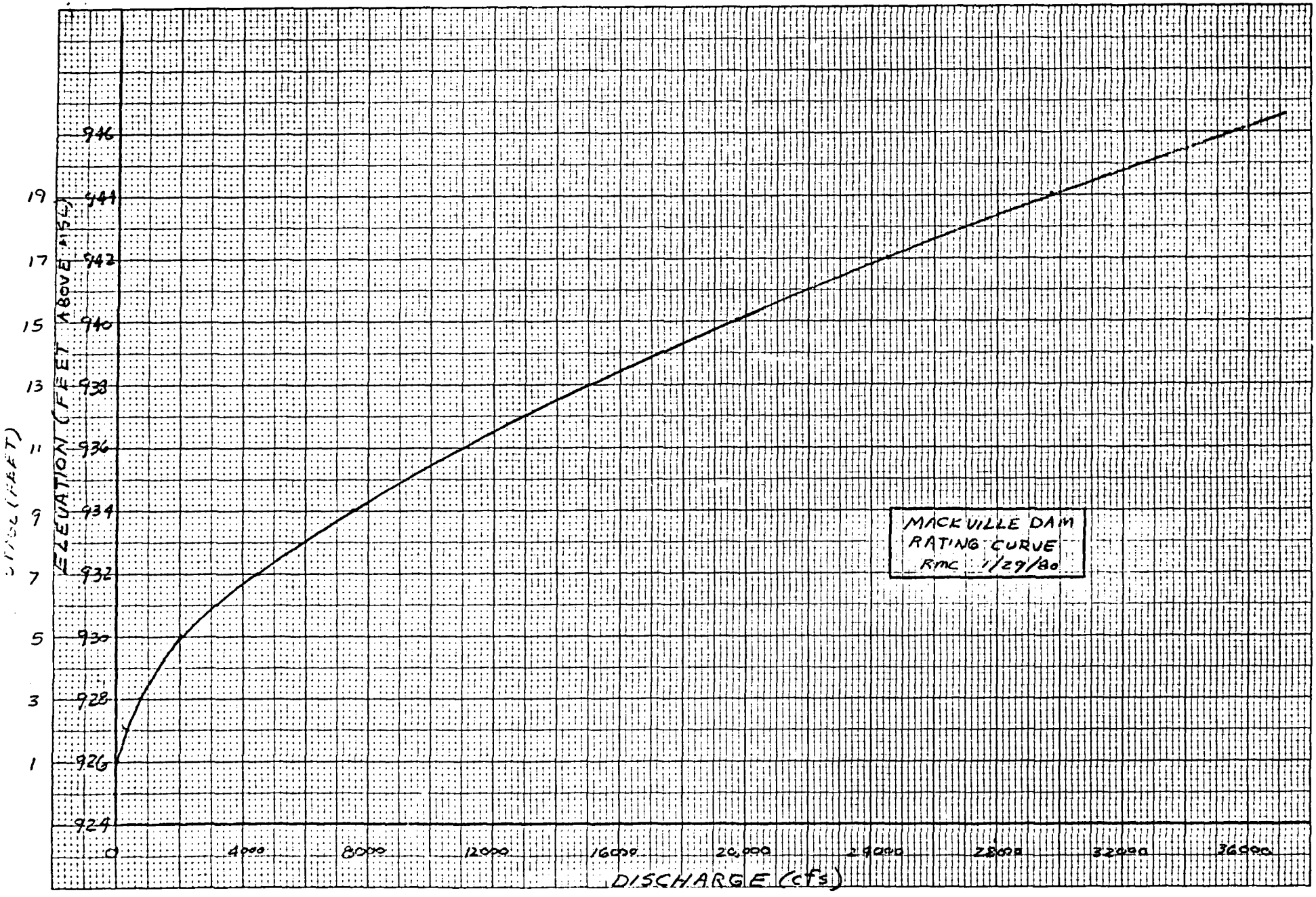
$C_w = 2.6$ (based upon field conditions)

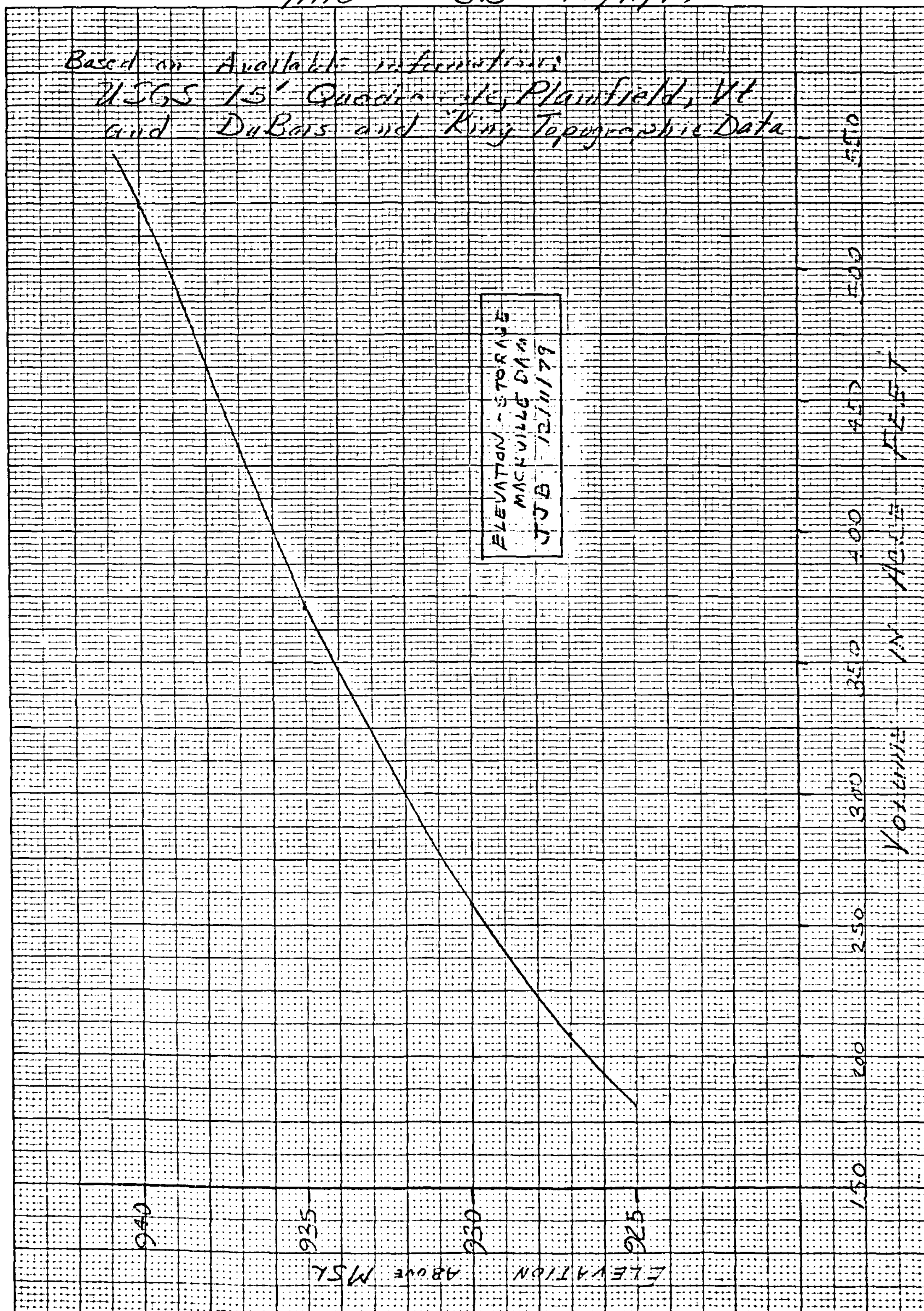
OUTLET ASSUMED NON EFFECTIVE IN FLOW COMPUTATIONS. THE WASTE GATE IS INOPERABLE AND THE PENSTOCK GATE OPENING MECHANISM IS LOCATED IN THE MIDDLE OF THE SPILLWAY, MAKING ITS USE UNLIKELY DURING A FLOOD.

Job No. 9/1116 Sheet 27 of 46
Project Mackville Pond Dam Date 1/29/80
Subject Hydrology / Hydraulics By RMC Chk. by

ELEVATION	SPILLWAY ELEVATION (925)		Dam Crest (927)		Roadway (929.3)	dike	TOTAL FLOW
	H	Q	H	Q	H	Q	
(ft)	(ft)	(cfs)	(ft)	(cfs)	(ft)	(cfs)	(cfs)
926	1	121	–	–	–	–	121
927	2	342	0	–	–	–	342
928	3	628	1	125	–	–	753
929.3	4.3	1078	2.3	434	0	–	1512
930	5	1352	3	647	0.7	114	2113
932	7	2239	5	1392	2.7	865	4496
934	9	3264	7	2306	4.7	1987	7557
936	11	4411	9	3362	6.7	3382	11,155
938	13	5667	11	4592	8.7	5004	15,213
940	15	7024	13	5836	10.7	6825	19685
942	17	8474	15	7233	12.7	8826	24,533
944	19	10,013	17	8727	14.7	10,990	29,730

K·E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.





46 1320
K+E 10 X 10 TO 1/2 INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

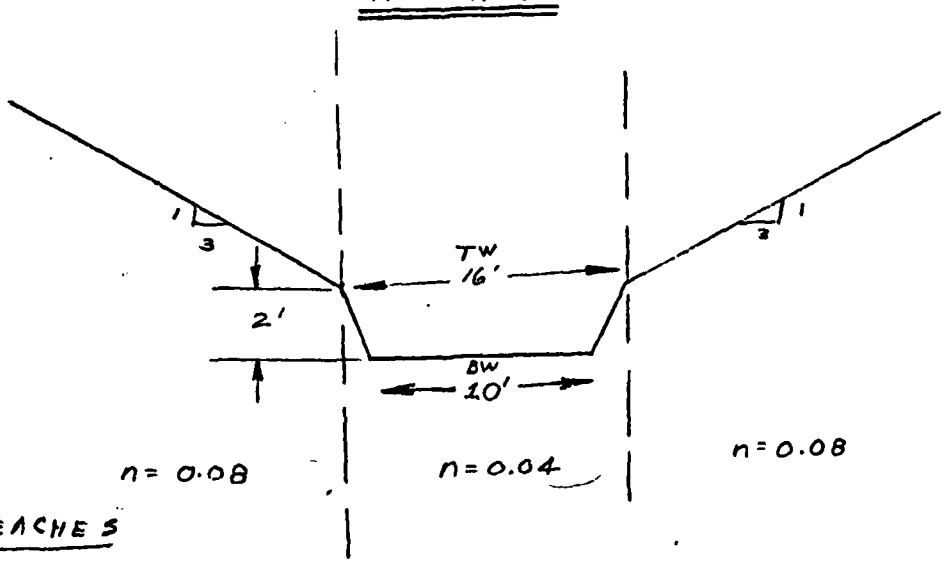
Job No. 9116 Sheet 30 of 46
Project MACKVILLE POND DAM Date 12/1/79
Subject HYDRAULICS / HYDROLOGY By RMC Ch'k. by

STEP 3

STAGE - DISCHARGE ROUTING CURVE

DOWNSTREAM XS APPROXIMATED FROM X SECTIONAL DATA SURVEYED BY DUBOIS AND KING PERSONNEL RELATING TO FLOOD INSURANCE STUDY FOR TOWN OF HARDWICK, VT

REACH 1



2 REACHES

Reach 1 L = 1500'
Δelev = 23'
S = 23/1500 = 0.0153

Reach 2 L = 500
Δelev = 67'
S = 67/500 = 0.1340

Job No. 9116
Project Mackville Pond Dam
Subject Hydraulics
Sheet 31 of 46
Date 1/29/80
By PMC Ch'k. by

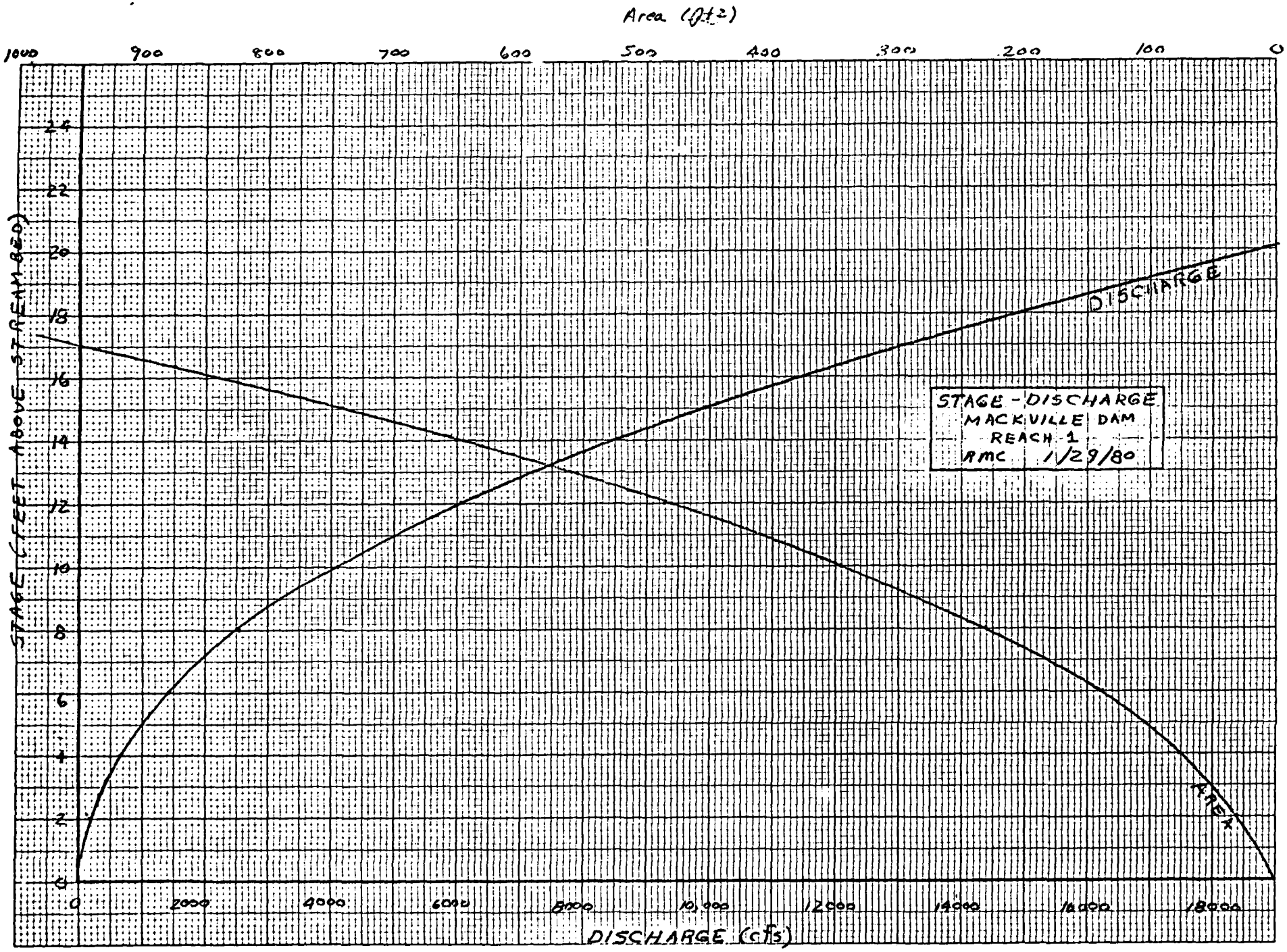
MANNINGS EQUATION USED

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \qquad R = A/P$$

		CHANNEL		RIGHT OVERBANK			LEFT OVERBANK			TOTAL	TOTAL
STAGE	AREA	WETTED PERIMETER	FLOW	AREA	WETTED PERIMETER	FLOW	AREA	WETTED PERIMETER	FLOW	AREA	FLOW
(ft)	(ft^2)	(ft)	(cfs)	(ft^2)	(ft)	(cfs)	(ft^2)	(ft)	(cfs)	(ft^2)	(cfs)
2	26	17.2	158	-	-	-	-	-	-	26	158
4	58	17.2	600	6	6.3	13	6	6.3	13	84	626
6	90	17.2	1248	24	12.6	85	24	12.6	85	138	1418
8	122	17.2	2072	54	19	249	54	19	249	230	2570
10	154	17.2	3054	96	25.3	537	96	25.3	537	346	4128
12	186	17.2	4125	150	31.6	966	150	31.6	966	486	6057
15	234	17.2	6038	253.5	41.1	1940	253.5	41.1	1940	741	9919
18	282	17.2	8231	384	50.6	3370	384	50.6	3370	1050	14,972
21	330	17.2	10685	541.5	60.1	5323	541.5	60.1	5323	1413	21,331

K•Σ 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

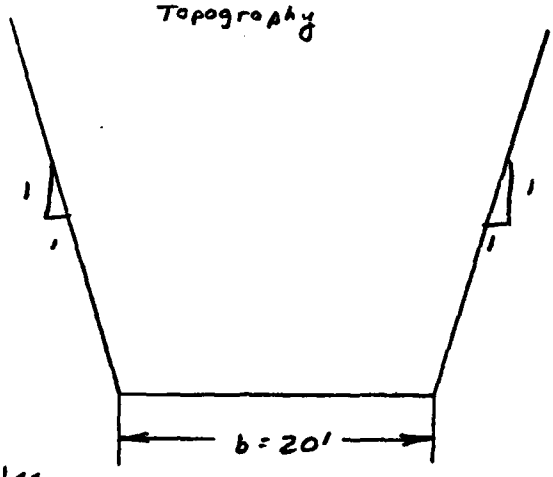
46 1320



Job No. 91116 Sheet 33 of 46
Project Mackville Dam Date 1/29/80
Subject Hydraulics By RMC Ch'k. by

REACH 2

XS Approximated from Topography



Reach Length = 500'

$\Delta elev = 887 - 820 = 67'$

$S = \Delta elev / L = 67/500 = 0.1340$

B) Normal depth found via Manning's equation $Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$

c) Critical depth from table 8-4 King and Brater p. 8-53

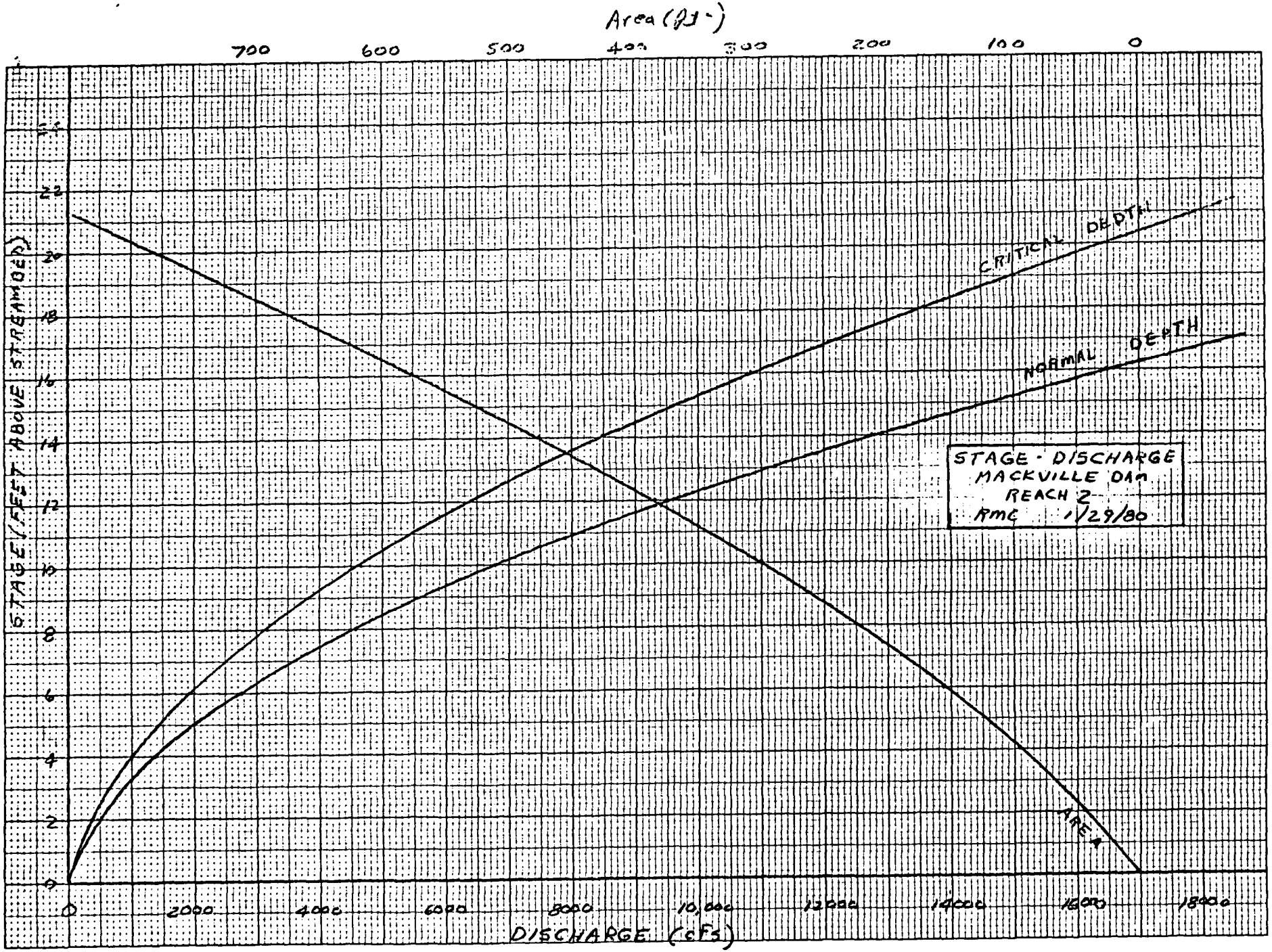
* Refer to Hydraulic and Excavation tables USBR

n = 0.08 rock channel, huy. wood

				B	C
d	A *	R *	$R^{2/3}$	Q_n	Q_c
STAGE (ft)	AREA (ft^2)	HYDRAULIC RADIUS		NORMAL FLOW (cfs)	CRITICAL FLOW (cfs)
2	44	1.71	1.43	429	338
4	96	3.07	2.11	1377	1008
6	156	4.22	2.61	2770	1953
8	224	5.25	3.02	4603	3168
10	300	6.21	3.34	6809	4658
12	384	7.12	3.65	9538	6435
14	476	7.99	3.94	12,758	8500
16	576	8.83	4.21	16,492	10875

Assume critical depth at throat

K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



Job No. 91116 Sheet 35 of 46
Project Mackville Pond Dam Date 1/29/80
Subject Hydraulics By PMC Ch'k. by

AT CONFLUENCE W/ COOPER BROOK, FLOOD WAVE WILL MEET A LARGE OPEN AREA, which acts as a reservoir. ELEVATION-STORAGE CURVE WILL BE DERIVED, EFFECTS ON FLOOD WAVE WILL BE DETERMINED USING OUTLET CHANNEL AS A CONTROL.

MAP SCALE 1" = 400'

CONVERSION FACTOR FOR PLANIMETER

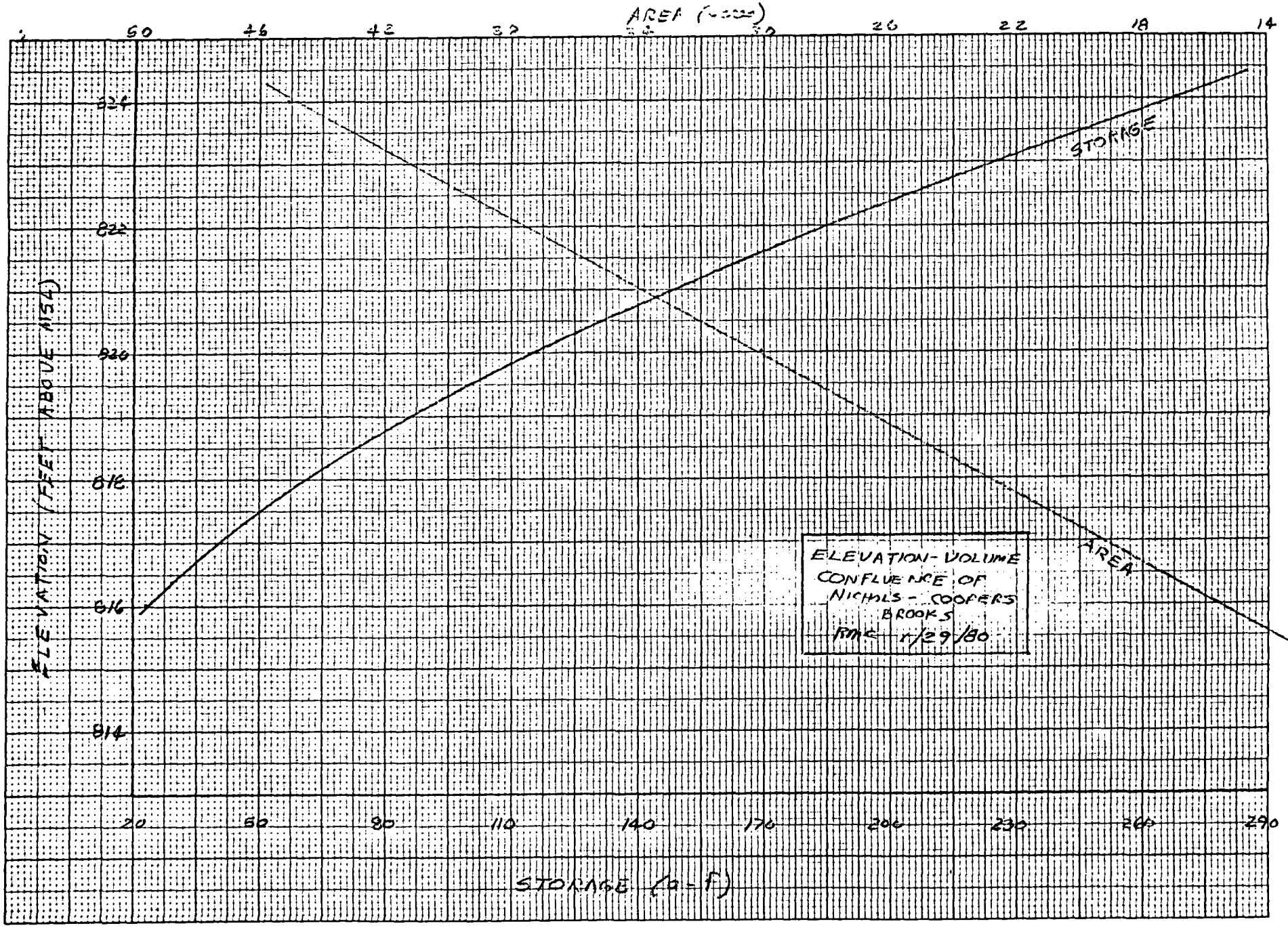
$$1\square'' = (400)^2 \text{ ft}^2 \times \frac{1 \text{ acre}}{43560 \text{ ft}^2} = 3.673 \text{ acre}$$

$$1\square'' = 3.673 \text{ acre}$$

	PLANIMETER READINGS					AVERAGE	SLICE	INCREMENTAL	TOTAL
ELEVATION	#1	#2	#3	AVERAGE	AREA	AREA	HEIGHT	VOLUME	VOLUME
(ft)	(in^2)	(in^2)	(in^2)	(in^2)	(acre)	(acre)	(ft)	(a-f)	a-f
									0
813	–	–	–	–	0				
						7.88	3	23.64	23.6
816	4.27	4.29	4.31	4.29	15.76				
						23.14	4	92.56	116.0
820	8.32	8.30	8.30	8.31	30.51				
						38.09	4	152.36	268.3
824	12.50	12.40	12.40	12.43	45.67				

K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

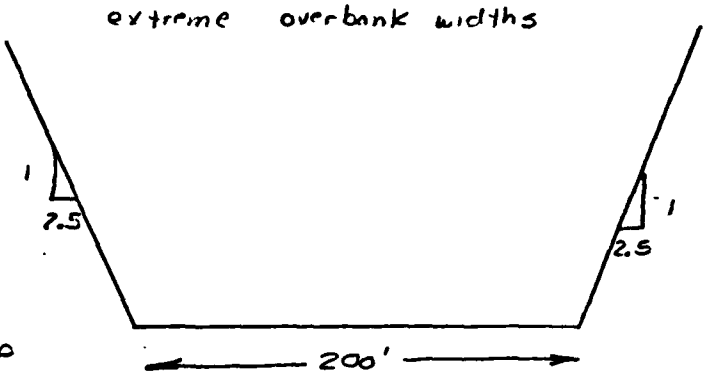
46 1320



Job No. 91116 Sheet 37 of 46
Project Mackville Dam Date 1/29/80
Subject Hydraulics By RMC Ch'k. by

REACH 3

XS approximated from topography
channel itself neglected due to extreme overbank widths



n = 0.05 Rock channel, Brush overbanks

REACH CHARACTERISTICS

$L = 2600'$

$\Delta elev = 814 - 806 = 8'$

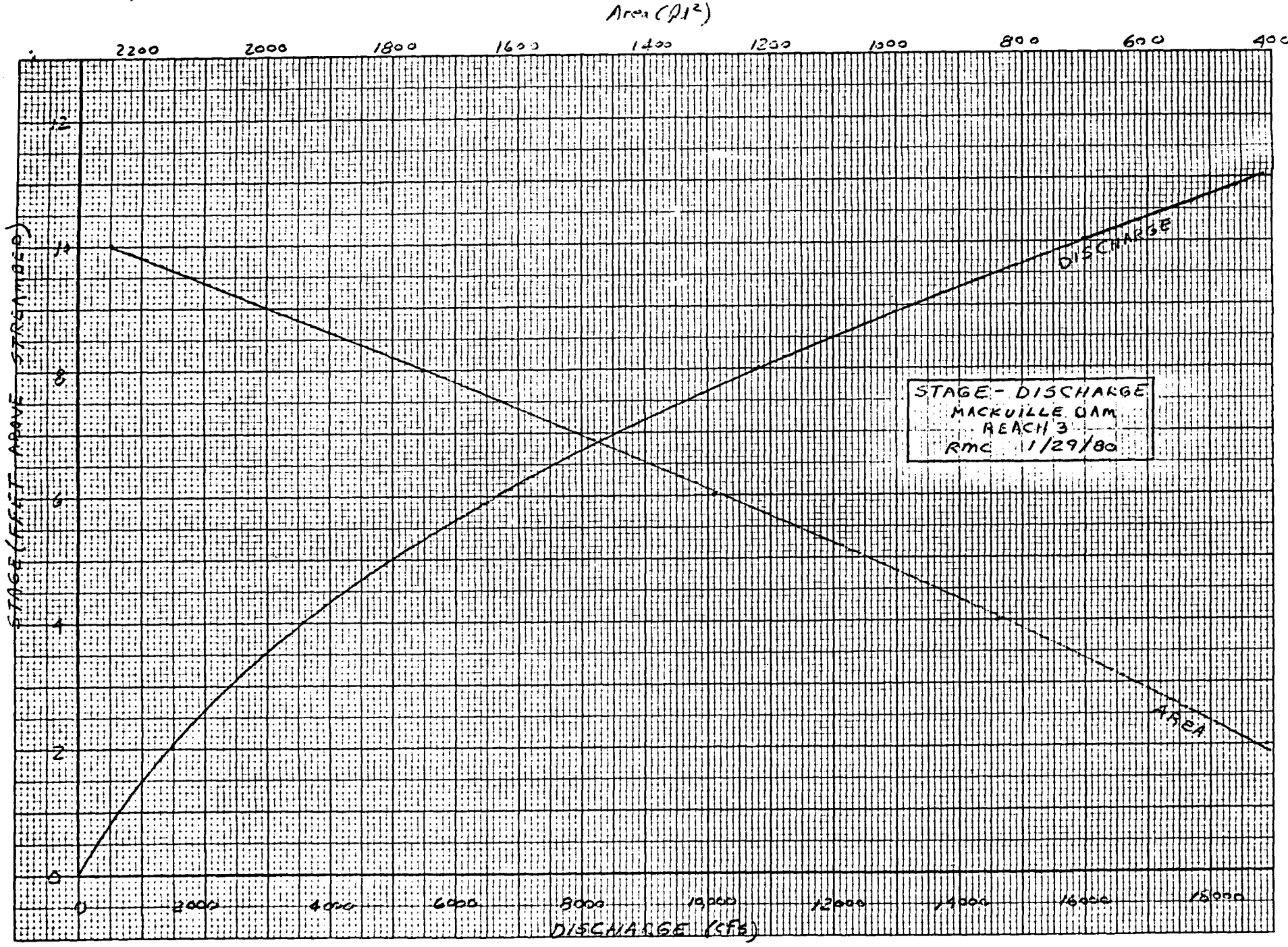
$S = \Delta elev / L = 8/2600 = 0.0031$

MANNINGS EQUATION USED

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ $R = A/P$

STAGE (ft)	AREA (ft^2)	WETTED PERIMETER (ft)	R	$R^{2/3}$	Q (cfs)
2	410	210.8	1.945	1.559	1061
4	840	221.5	3.792	2.433	3391
6	1290	232.3	5.553	3.138	6716
8	1750	243.1	7.199	3.731	10,833
10	2250	253.9	8.862	4.285	15,997
12	2760	264.6	10.430	4.777	21,876

K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



Job No. 91110 Sheet 39 of 46
Project East Long Pond Dam Date 1/30/80
Subject Channel Routing By RMC Ch'k. by

STEP 4 ROUTE DAM BURST FLOW DOWNSTREAM

Q_{P_1} = 10,500 cfs. (refer page 13)

ENTER EAST LONG POND OUTLET (Refer page 13-15)

stage = 8.5' area = 395 □'

L = 1750'

$$V_1 = \frac{1750' \times 395\ \square'}{43560\ \square'/\text{acre}} = 15.9\ \text{a-F} < \frac{3619}{2}\ \text{a-f}$$

Reach length OK

$$Q_{P\,trial} = Q_{P_1}\left(1 - \frac{V_1}{3619}\right) = 10,500\left(1 - \frac{15.9}{3619}\right) = 10,454\ \text{cfs}$$

stage = 8.45' area = 392 □'

$$V_2 = \frac{392 \times 1750}{43560} = 15.8\ \text{a-f}$$

$$V_{ave} = (15.8 + 15.9)/2 = 15.85\ \text{a-f}$$

$$Q_{P_2} = 10500\left(1 - \frac{15.85}{3619}\right) = 10,454\ \text{cfs}$$

OUTFLOW = 10,454 cfs stage = 8.5'

ENTER NICHOLS POND - INVESTIGATE SURCHARGE STORAGE EFFECTS ON FLOOD PEAK (Refer pages 16-23) (Nichols Pond assumed at Maximum pool (el. 1130.5' -) max storage = 2841 a-f

Q_{P_1} = 10,454 cfs SURCHARGE HEIGHT = 9.8' (el. 1137.8')

V_1 = SURCHARGE STORAGE = 4300 a-f - 2841 a-f = 1459 a-f

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{V_1}{3619}\right) = 10454\left(1 - \frac{1459}{3619}\right) = 6240\ \text{cfs}$$

Job No. 91110 Sheet 40 of 46
Project East Long Pond Dam Date 1/30/80
Subject Channel Routing By RMC Ch'k. by

SURCHARGE HEIGHT$_2$ = 7.75' (el. 1135.75')

V_2 = 3975 - 2841 = 1134 a-f

V_{ave} = (1134 + 1459)/2 = 1297 a-f

$Q_{P_3} = 10454\left(1 - \frac{1297}{3619}\right) = 6709$ cfs

SURCHARGE HEIGHT$_3$ = 8.0' (el. 1136.0')

V_3 = 4000 - 2841 = 1159 a-f

V_{ave} = (1159 + 1134)/2 = 1147 a-f

$Q_{P_4} = 10454\left(1 - \frac{1147}{3619}\right) = 7142$ cfs

SURCHARGE HEIGHT$_4$ = 8.25' (el 1136.25')

V_4 = 4050 - 2841 = 1209 a-f

V_{ave} = (1209 + 1147)/2 = 1178 a-f

$Q_{P_5} = 10454\left(1 - \frac{1178}{3619}\right) = 7051$ cfs

SURCHARGE HEIGHT$_5$ = 8.2' (el 1136.2')

V_5 = 4050 - 2841 = 1209 a-f

V_{ave} = (1178 + 1209)/2 = 1193.5 a-f

$Q_{P_6} = 10454\left(1 - \frac{1193.5}{3619}\right) = 7606$ cfs

SURCHARGE HEIGHT$_6$ = 8.2' (el 1136.2')

SURCHARGE HEIGHT$_6$ = SURCHARGE HEIGHT$_5$ = 8.2' (el. 1136.2')

NO FURTHER ITERATIONS NECESSAY, VALUES WILL NOT CHANGE SIGNIFICANTLY

OUTFLOW = 7606 cfs STAGE at Dam 8.2'

Job No. 9111O Sheet 41 of 46
Project East Long Pond Dam Date 1/30/80
Subject Channel Routing By RMC Ch'k. by

ENTER NICHOLS POND OUTLET (refer pages 24-25)

Q_{P_1} = 7606 cfs stage = 11.8' area = 565 □'

$V_1 = \frac{565\ \square' \times 10500'}{43560\ \square'/\text{acre}} = 136.2$ a-f < $\frac{3619}{2}$ a-f ∴ Length OK

L = 10,500'

$Q_{P\,trial} = Q_{P_1}\left(1 - \frac{V_1}{3619}\right) = 7606\left(1 - \frac{136.2}{3619}\right) = 7320$ cfs

stage = 11.6' area = 540 □'

$V_2 = \frac{540 \times 10500}{43560} = 130.2$ a-f

$V_{ave} = (130.2 + 136.2)/2 = 133.2$ a-f

$Q_{P_2} = 7606\left(1 - \frac{133.2}{3619}\right) = 7326$ cfs

OUTFLOW = 7326 cfs STAGE = 11.6'

ENTER MACKUILLE POND - INVESTIGATE SURCHARGE STORAGE EFFECTS ON FLOOD PEAK (refer pages 26-29) (Mackuile pond assumed @ maximum pool level (el. 927.0) (storage = 208 a-f)

Q_{P_1} = 7326 cfs SURCHARGE HEIGHT$_1$ = 6.8' (el. 933.8)

V_1 = SURCHARGE VOLUME = 342.5 - 208 = 134.5 a-f

$Q_{P_2} = Q_{P_1}\left(1 - \frac{V_1}{3619}\right) = 7326\left(1 - \frac{134.5}{3619}\right) = 7054$ cfs

SURCHARGE HEIGHT$_2$ = 8.6' (el 933.6)

V_2 = 337.5 - 208 = 129.5 a-f

$V_{ave} = (129.5 + 134.5)/2 = 132$ a-f

Job No. 91110 Sheet 42 of 46
Project East Long Pond Dam Date 1/30/80
Subject Channel Routing By RMC Ch'k. by

$$Q_{P_3} = 7326\left(1 - \frac{132}{3619}\right) = 7058 \text{ cfs}$$

SURCHARGE HEIGHT$_3$ = 8.6' (el. 933.6')

SURCHARGE HEIGHT$_3$ = SURCHARGE HEIGHT$_2$ = 8.6'

NO FURTHER ITERATIONS NECESSARY, VALUES WILL NOT CHANGE

OUTFLOW = 7058 cfs STAGE at Dam = 8.6'

NOTE - FLOW DIVIDED AT DAM between spillway and dike

ENTER REACH 1 MACKUILLE DAM

Q_{P_1} = 7058 cfs stage = 12.9' area = 550$^{\square}$'

$$V_1 = \frac{550^{\square}' \times 1500'}{43560^{\square}'/\text{acre}} = 18.9 \text{ a-f} \angle \frac{3619}{2} \text{ a-f}$$

$$Q_{P_{trial}} = 7058\left(1 - \frac{18.9}{3619}\right) = 7021 \text{ cfs}$$

L_1 = 1500'

stage = 12.9' area = 550$^{\square}$'

$A_1 = A_2 = 550^{\square}' \Rightarrow V_1 = V_2 = V_{ave} = 18.9$ a-f

Since Volume will not change, $Q_{P_{trial}}$ is OK

OUTFLOW = 7021 cfs stage = 12.9'

ENTER REACH 2 MACKUILLE DAM (configuration resembles throat, critical depth at entrance)

Q_{P_1} = 7021 cfs stage = 12.7 area = 420$^{\square}$'

L_2 = 500'

$$V_1 = \frac{420^{\square}' \times 500'}{43560} = 4.8 \text{ a-f}$$

Job No. 91110 Sheet 43 of 46
Project East Long Pond Dam Date 1/30/80
Subject Channel Routing By RMC Ch'k. by

$Q_{P\,trial} = 7021\left(1 - \frac{4.2}{3619}\right) = 7012$ cfs

(Normal depth) stage = 10.2' area = 305 □'

$$V_2 = \frac{305^{\square'} \times 500'}{43560} = 3.5 \text{ a-f}$$

$V_{ave} = (3.5 + 4.8)/2 = 4.2$ a-f

$Q_{P_2} = 7021\left(1 - \frac{4.2}{3619}\right) = 7013$ cfs

OUTFLOW = 7013 cfs stage = 10.2'

ENTER CONFLUENCE COOPER-NICHOLS BROOKS

1) $Q_{P_1} = 7013$ cfs

2) Rating curve for exit channel controls, from Reach 3 Stage-Discharge Curve (P. 3E) $d_1 = 7.4'$

3) Elevation of valley floor = 814.0 (at exit channel)

4) Elevation of water surface = 814.0 + 7.4 = 821.4'

5) Enter Volume-Elevation Curve (P. 3G)

$V_1 = 162.5$ a-f $< \frac{3619}{2}$ a-f ∴ OK

$Q_{P_2} = Q_{P_1}\left(1 - \frac{V_1}{3619}\right) = 7013\left(1 - \frac{162.5}{3619}\right) = 6698$ cfs

$d_2 = 6.0'$ (el 820.0) $V_2 = 116$ a-f

$V_{ave} = (116 + 162.5)/2 = 139.25$ a-f

$Q_{P_2} = 7013\left(1 - \frac{139.25}{3619}\right) = 6743$ cfs

$d_3 = 6.05$ (el 820.05') $V_3 = 117.5$ a-f

Job No. 91110 Sheet 44 of 46
Project East Long Pond Dam Date 1/30/80
Subject Channel Routing By EMC Ch'k. by

$V_{ave} = (117.5 + 139.25)/2 = 128.5$ a-f

$Q_{P_4} = 7013\left(1 - \frac{128.5}{3619}\right) = 6764$ cfs

$stage_4 = 6.05'$ (el. 820.05') $V_4 = 117.5$ a-f

$V_{ave} = (117.5 + 128.5$ a-f$)/2 = 123$ a-f

$Q_{P_5} = 7013\left(1 - \frac{123}{3619}\right) = 6775$ cfs

$stage_5 = 6.05'$ (el. 820.05')

$stage_3 = stage_4 = stage_5 = 6.05'$, NO FURTHER ITERATIONS NECESSARY, VALUES WILL NOT CHANGE

OUTFLOW = 6775 cfs STAGE = 6.05 ≈ 6.1' (el. 821.1)

ENTER MACKUILLE DAM REACH 3 (refer p. 37-38)

INFLOW = 6775 cfs stage = 6.1' area = 1300 □'

$V_1 = \frac{2600' \times 1300\,□'}{43560} = 77.6$ a-f

$L_3 = 2600'$

$Q_{P_{trial}} = 6775\left(1 - \frac{77.6}{3619}\right) = 6630$ cfs

stage = 6.0' area = 1280 □'

$V_2 = \frac{1280 \times 2600}{43560} = 76.4$ a-f

$V_{ave} = (76.4 + 77.6)/2 = 77.0$ a-f

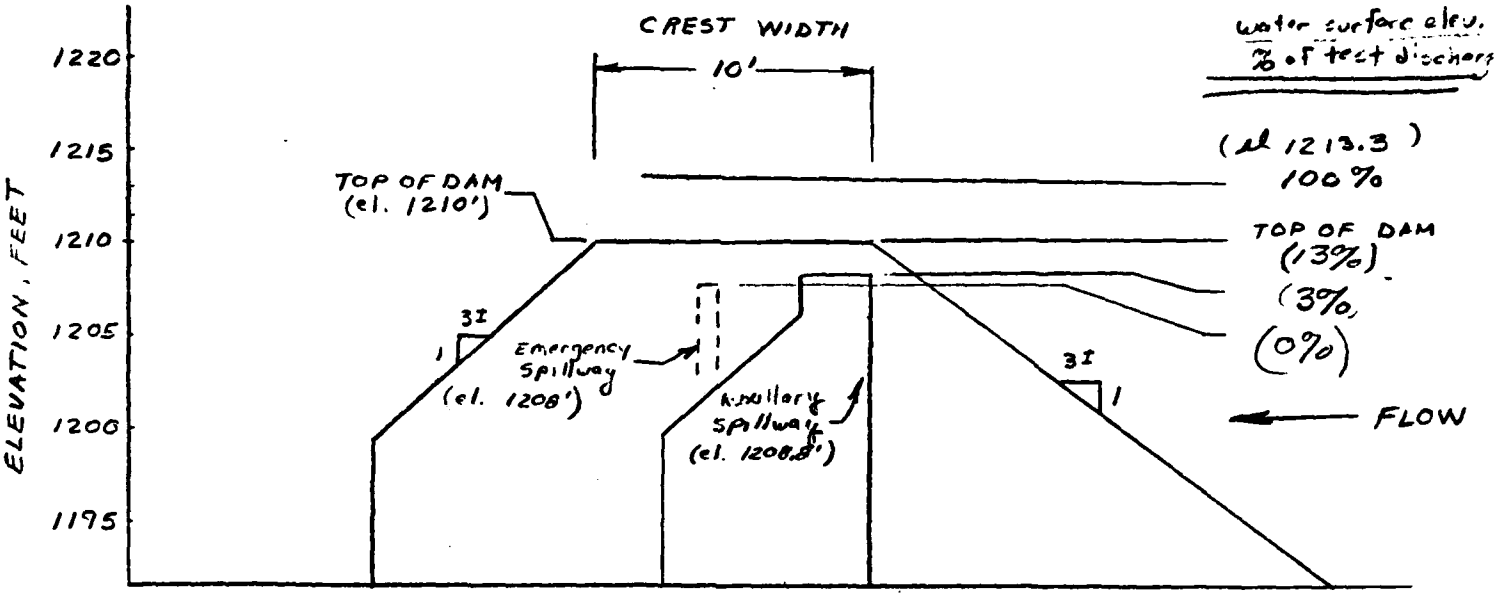
$Q_{P_2} = 6775\left(1 - \frac{77.0}{3619}\right) = 6631$ cfs

OUTFLOW = 6631 cfs stage = 6.0'

Job No. 91110 Sheet 45 of 46
Project East Long Pond Dam Date 1/30/80
Subject Channel Routing Summary By RMC Ch'k. by

REACH	DISCHARGE (cfs)	STAGE (Ft)	FLOOD WAVE (Ft)
AT DAM	10500 cfs	8.5'	6.5'
1750' DS (ENTER NICHOLS POND)	10,454 cfs	8.5'	6.5'
5750' DS (LEAVE NICHOLS POND)	7606 cfs	11.8'	8.2'
16,250' DS (ENTER MACKUILLE POND)	7326 cfs	11.6'	8.0
18,250' DS (EXIT MACKUILLE POND)	7058 cfs	12.9'	10.9'
19,750' DS (END REACH 1 OF MACKUILLE DAM (1500' DS OF MACKUILLE DAM))	7021 cfs	12.9'	8.6'
20,250' DS (END REACH 2 OF MACKUILLE DAM (2000' DS OF MACKUILLE DAM))	7013 cfs	10.2'	7.3'
22,050' DS (CONFLUENCE OF COOPER-NICHOLS BROOK) (3800' DS OF MACKUILLE DAM	6775 cfs	6.1'	5.1'
ENTER OUTSKIRTS OF HARDWICK VILLAGE (24,650' DS OF East Long Pond dam) (6400' DS OF MACKUILLE DAM)	6631 cfs	6.0'	5.0'

Job No. 91110 Sheet 46 of 46
Project EAST LONG POND DAM Date 11/29/79
Subject SPILLWAY CAPACITY DATA By RMC Ch'k. by

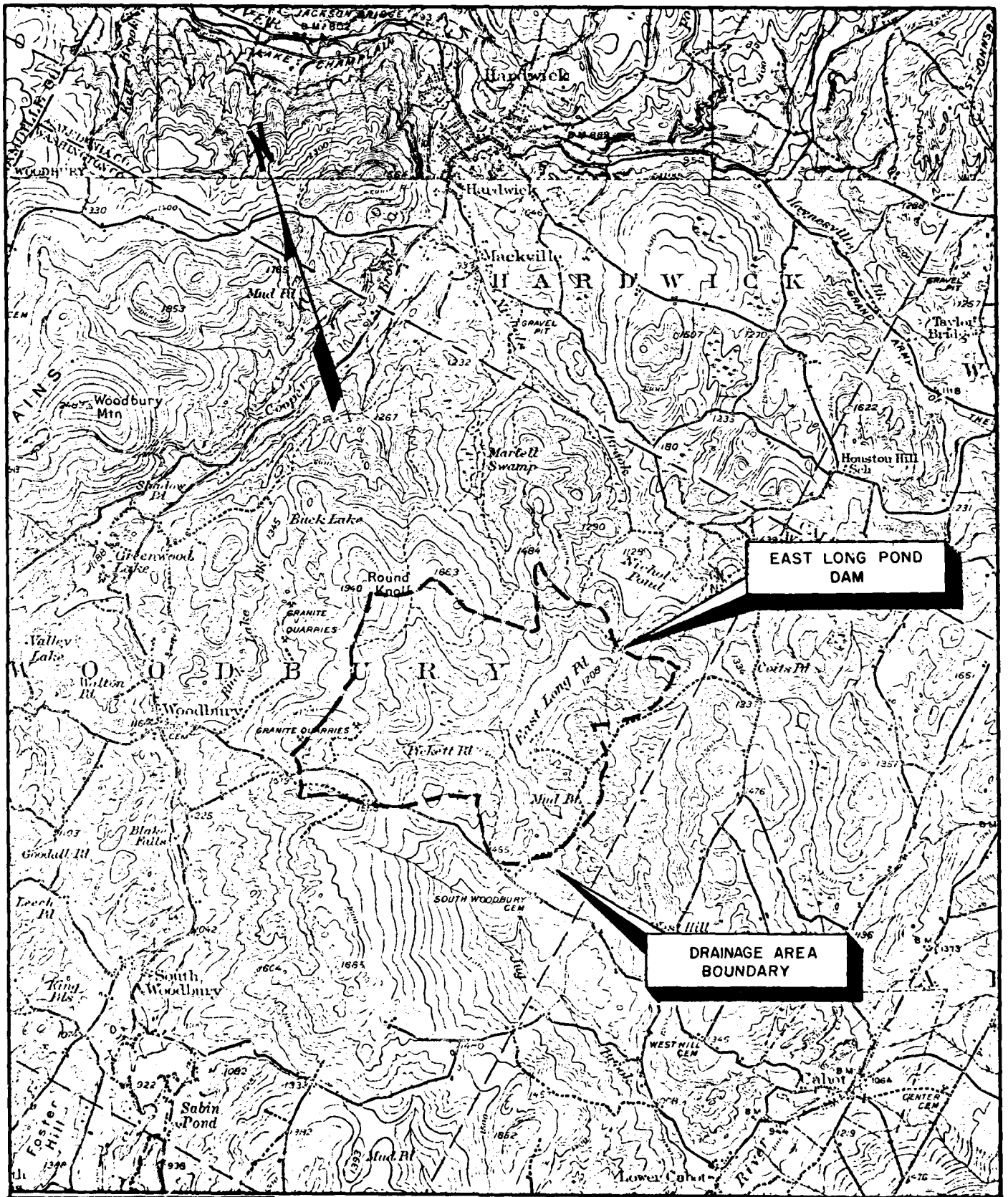


NOT TO SCALE

PMF = TEST INFLOW = 8100 cfs

SPILLWAY CAPACITY
EAST LONG POND DAM

CONDITION AT DAM	WATER SURFACE ELEVATION	TOTAL DISCHARGE (cfs)	AUXILLARY SPILLWAY CONTRIBUTION		EMERGENCY SPILLWAY CONTRIBUTION	
			DISCHARGE (cfs)	% OF TOTAL DISCHARGE	DISCHARGE (cfs)	% OF TOTAL DISCHARGE
TEST FLOOD (DAM OVERTOPPED)	1213.3	5645	335	6%	3035	54%
DAM CREST	1210	747	46	6%	701	94%
WATER UP TO AUXILLARY SPILLWAY	1208.8	177	0	-	177	100%
WATER UP TO EMERGENCY SPILLWAY	1208.0	0	0	-	0	-



DuBois & King inc.
engineering and environmental services
RANDOLPH, VERMONT CONCORD, NEW HAMPSHIRE

NATIONAL DAM INSPECTION PROGRAM

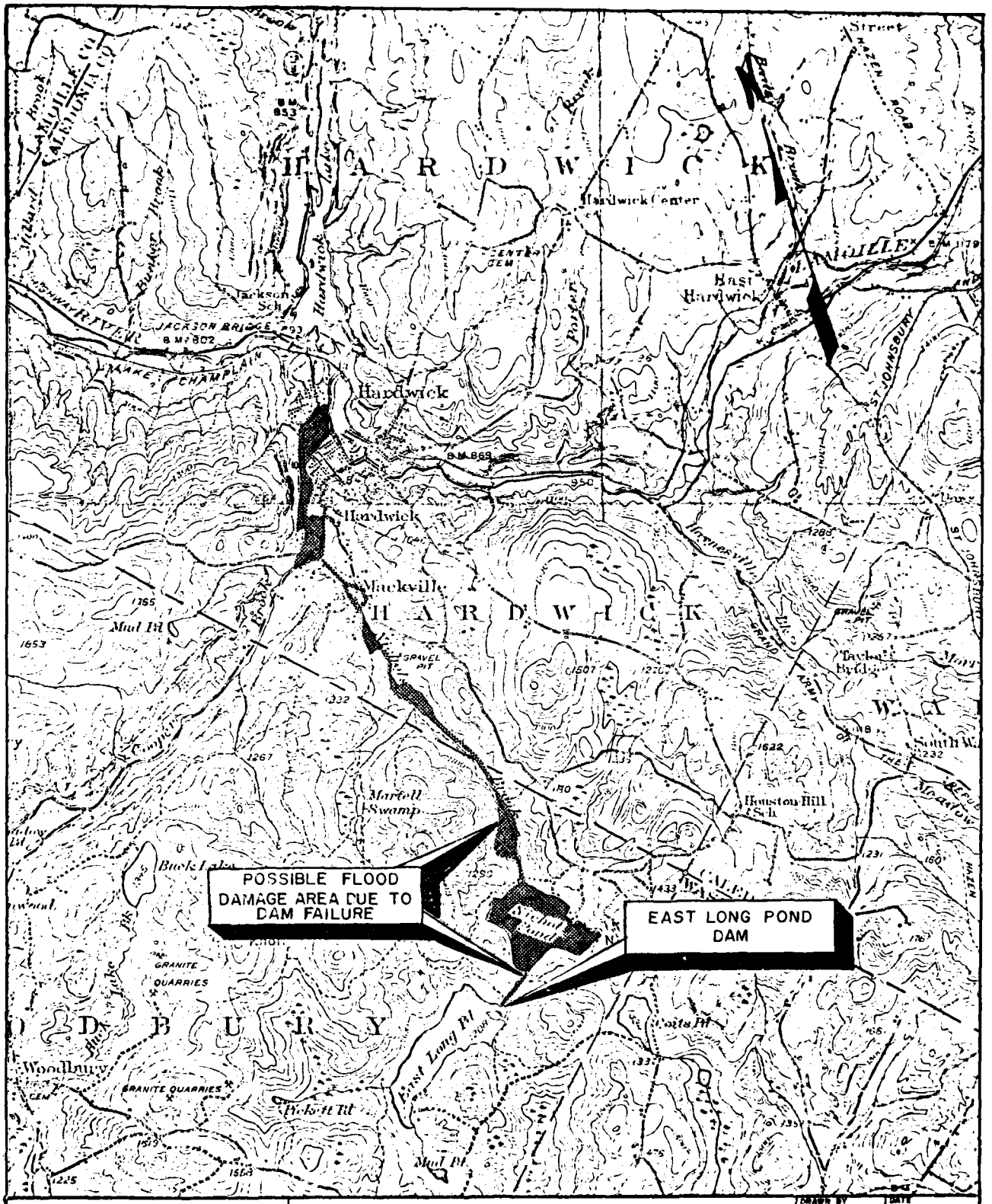
EAST LONG POND DAM

DRAINAGE AREA

USGS QUAD - PLAINFIELD, VERMONT

DRAWN BY	DATE
JAS	12/79
CHECKED BY	PROJ. NO.
RMC	91110
PROJ ENG	DRAW NO

SCALE: 1"=62500



DuBois & King Inc.
engineering and environmental services
RANDOLPH, VERMONT CONCORD, NEW HAMPSHIRE

NATIONAL DAM INSPECTION PROGRAM

EAST LONG POND DAM

POSSIBLE FLOOD DAMAGE AREA

USGS QUAD - PLAINFIELD, VERMONT

DRAWN BY	DATE
JAS	12/79
CHECKED BY	PROJ NO
	91110
PROJ ENG	DRAW NO

SCALE 1"=62500

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY	MO	YR
VT	185	NED	VT	023	01				EAST LONG POND DAM	4426.9	7220.9	18	JUL	80

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	EAST LONG POND

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	01	NICHOLS BROOK	HARDWICK	5	2700

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)	(27) DIST	DAM	FED R	PRV/FED	SCS A	VER/DATE
RLPG	1930	RO	20	20	3620	3250	NED	N	N	N	N	

(28) REMARKS
AUGMENTATION

(29) DAMS HAS	(30) SPILLWAY CREST LENGTH (FT.)	(31) TYPE	(32) WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	PROPOSED (MW)	(36) NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	260	U	70	745	1650											

(37) OWNER	(38) ENGINEERING BY	(39) CONSTRUCTION BY
VILLAGE OF HARDWICK	TROJAN ENGINEERING CO.	TROJAN ENGINEERING CO.

(40) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
VT PUB SERV COMM	VT PUB SERV COMM	NONE	VT DEPT WTR RES

(41) INSPECTION BY	(42) INSPECTION DATE DAY	MO	YR	(43) AUTHORITY FOR INSPECTION
DUBOIS + KING INC.	26	OCT	79	P.L. 92-367

(44) REMARKS

END

FILMED

9-85

DTIC